Deliverable 9.4 Part 1

Envisaged EU mobility models, role of involved entities, and Cost Benefit Analysis in the context of the European Clearing House mechanism

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List of Abbreviations

AC	Alternating Current
BM	Business Model
BRP	Balancing Responsible Party
B2B	Business to Business
B2C	Business to Customer
CDR	Charge Detail Record
CEO	Chief Executive Officer
CET	Central European Time
CH	Clearing House
CRM	Customer Relationship Management
DC	Direct Current
DER	Distributed Energy Resources
DSO	Distribution System Operator
EBITDA	Earnings Before Interest, Taxes, Depreciation and Amortization
EC	European Commission
EMO	Electricity Market Operator
EU	European Union
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
EVSP	Electric Vehicle Service Provider
GSM	Global System for Mobile communications
ICT	Information and Communication Technologies
ID	Identification
IEC	International Electrotechnical Commission
IRR	Internal Rate of Return
ISO	International Organization for Standardization
KPI	Key Performance Indicator
LT	Long-term (scenario)
MO	Meter Operator
MT	Medium-term (scenario)
NPV	Net Present Value
OEM	Original Equipment Manufacturer
O&M	Operation and Maintenance
PI	Performance Indicator
QoS	Quality of Service
RFID	Radio Frequency Identification
SLA	Service Level Agreement
SLO	Service Level Objective
ST	Short-term (scenario)
TCO	Total Cost of Ownership
TOU	Time of Use
TSO	Transmission System Operator
T&D	Transmission and Distribution
UC	Use case
UCM	Use Case Maps
WP	Work Package

1 Executive summary

The business models (BM) analysis performed in Green eMotion seeks to identify the BMs most suited to facilitate large-scale electric vehicles (EV) roll-out in terms of social acceptance, commercial viability and system/environmental impact. This document contains a first evaluation of the economic performance of the BMs based on the Green eMotion reference architecture for electromobility. A second version of this report will be delivered in February 2015.

Beside the economic performance, also the quality and effectiveness of electromobility services provided by using the Green eMotion information and communication technologies (ICT) architecture needs to be evaluated. Therefore a set of key performance indicators (KPIs) was defined in the categories of 1) Cost 2) Time 3) Quality of Service and 4) Service Performance. These KPIs are intended to allow for the measurement and reporting of key aspects of system and service performance both within an ICT and business context. In addition to this, they will facilitate the assessment of the suitability of various BMs for use in both the ICT marketplace and across geographical borders through the clearing house concept.

EV-related BMs are networked business models, in which several actors interrelate with each other and all call for a positive business case. Therefore, the BM analysis does not only focuses on the actors who want to launch the business (e.g. Electric Vehicle Supply Equipment (EVSE) Operator or Electric Vehicle Service Provider (EVSP)), but also on all the players that must or can be involved across the value chain, including some regulated companies (such as Transmission System Operator (TSO), Distribution System Operator (DSO) or Electricity Market Operator (EMO)) and liberalized stakeholders (such as electricity retailers or producers). The actors involved in the EV ecosystem are recalled in this report.

Three main services are considered: basic charging, EVSE reservation and congestion/load management. As the charging service is the most basic service related to electric mobility, a detailed economic assessment of the provision of such service is presented.

In the unbundled business model for the service "basic charging" the DSO, the electricity retailer, the EVSP and the EVSE operator are different legal entities. They have contracts in place that finally allow the EVSP to offer charging services to the EV customer (EV driver) using the EVSEs of the EVSE operator. As a result the EVSE operator has the possibility to bill the EVSP for the charging event. The business process of clearing will be done by a Clearing House connected to a marketplace (see Figure 1). The outcomes we are presenting are therefore related to an unbundled business model where all actors are independent from each other.

The number of EV customers in the BM analysis is always the number related to one EVSP, meaning that we consider a market segment that is covered by one EVSP. If for example one country has several EVSPs, the number of EV customers in that country would be the sum of the EV customers of all EVSPs in that country. Likewise, the outcome is calculated for only one EVSE operator as an increase of their number will increase the complexity of the business case analysis significantly. The main difference in outcome for several operators would be an increase of fixed cost elements like overhead costs, so we calculate here the best case "all EVSEs operated by one company".

The public or semi-public infrastructure in the analysed business case is evenly distributed, so there is no differentiation in frequency of usage or other features. The infrastructure is considered to consist only of low-cost chargers (3.7 kW). However, it is likely that EV customers will be asking for medium or fast charging in public places (11 kW or more), which will increase the cost for the public infrastructure and therefore influence the business case analysis.

In order to derive concrete numbers for the analysis of the business model we created a mid-term basic business scenario. Therein it is assumed that the EVSP has 50 000 EV customers and the EVSE operator runs 10 000 EVSEs. The EV customers charge once per day at public EVSEs and the average charge is 3 kWh (in line with the results of WP1 [Brady 2013]). The latter assumption means that the EV customer would charge publicly for an equivalent of 9 100 km/year (calculated with an average value of 120 Wh/km), which is close to the annual average for EU cars [EC 2013, 3]).

If we now assume that only 10% of the charging events happen publicly, we need to consider a 10 times higher number of EV customers. So we end up with 500 000 EV customers using the 10 000 public EVSEs.

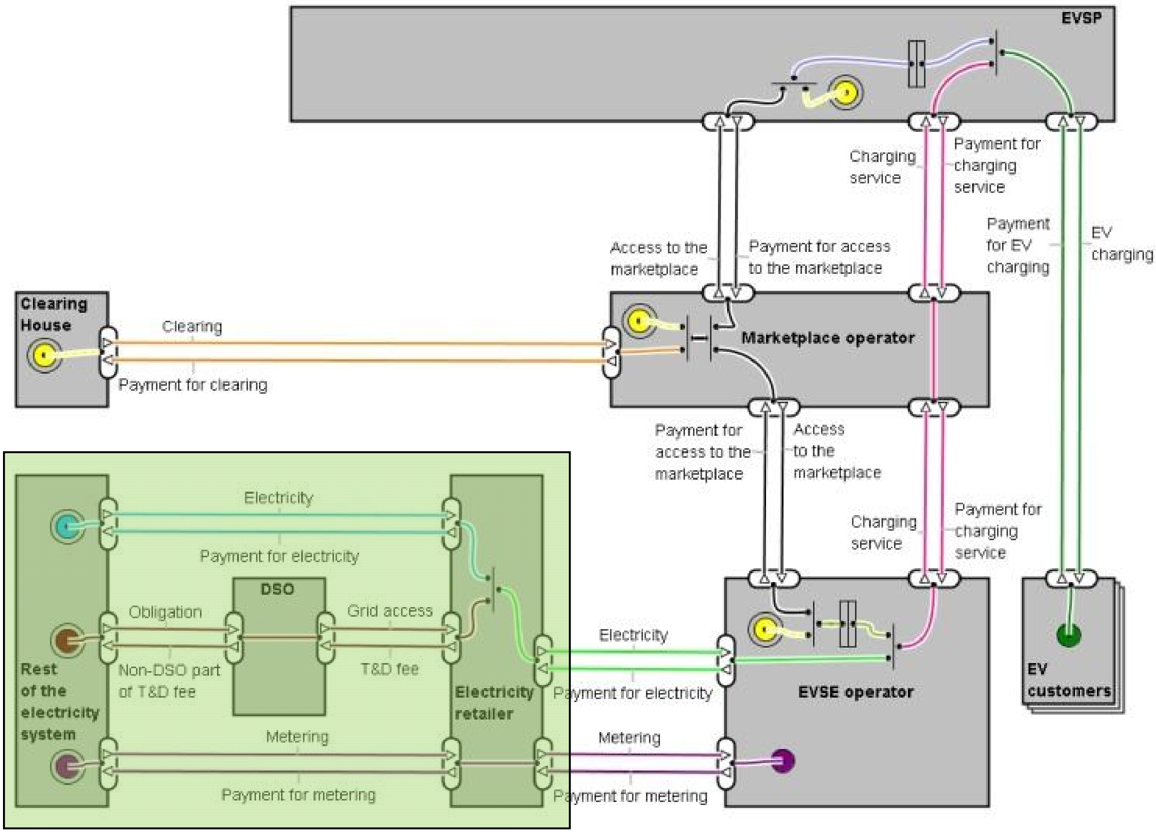

Figure 1: Model for the "basic charging" service under the unbundled business model

Using prices and the electricity market condition for Spain it was analysed that all business actors in the mid-term basic business scenario will have a profitable business (10% profit level) if the EV customer pays 1.42 € for the public charging event. That corresponds to a price of 0.47 cent per kWh or 1.4 € charging fee for 1 hour charging.

The end customer price of 1.4 € per hour for public charging plus an optional parking fee seems to be reasonable if we keep in mind that parking alone in city centres has price levels of 2 € per hour or more. On the other hand, in residential, medium to small urban areas and rural areas, drivers are not used to pay for parking at all. Also, several EU municipalities are already supporting EV uptake through free parking. The business model also implies that we will need 5 charging events per day at each of these public EVSEs (50 000 public charging events per day at 10 000 EVSEs).

These results lead to the conclusion that the business case of public charging as a stand-alone business (not linked to any other activity) can only be profitable within such mid-term business scenario in case of highly frequented EVSEs which are located at points of interest, so that people are willing to pay for the usage and usage time is short enough to allow for several charging events per day. Outside of this niche, the end customer pricing model looks non-competitive against conventional transportation. The upcoming second report on business model analysis will focus on infrastructure with selected features like location at point of interest or fast charging at highways. It will be analysed which part of the public charging business might show a positive business case in the mid-term future, considering the whole stakeholders value chain.

2 Introduction

2.1 Scope of the document

This document contains a first evaluation of the economic performance of the business models (BMs) related to electric mobility within Green eMotion project, as part of Task 9.3. This analysis will be further elaborated in the second version of this report, which will be delivered in February 2015.

The economic assessment presented in this report is based on the outcome of several workshops, meetings and phone conferences devoted to the BMs topic in Green eMotion. Of particular interest were the workshops in Bilbao (November 2011), Brussels (June 2013) and Munich (June 2013 and February 2014), where different industrial partners provided their views about future businesses around electric mobility. Among others, partners contributing to such discussions include OEMs (BMW, Nissan, Daimler), electric utilities (RWE, Enel), equipment manufacturers (Siemens, Bosch) and ICT companies (IBM), which ensures the relevance of the data and assumptions considered in the analysis.

This BM analysis focuses just on the monetary aspects related to e-mobility. A detailed description of the methodology and the process for the BM analysis can be found in the first interim report of Task 9.3 [IR 9.3.1], as well as in Annex I: Other methodological considerations.

For further details on other aspects, the reader should refer to other Green eMotion documents (all publicly available documents can be found at [GeM]):

- For communications, Work Package (WP) 3 documents. In particular, deliverables [D3.1], [D3.3] and [D3.4].
- For grid impact, WP4 documents. In particular deliverable [D4.2] and the three parts of deliverable D4.3, "Grid Impact studies of electric vehicles".
- For the impact on the power systems, Task 9.2 documents. In particular, deliverables 9.2 and 9.3 (to be delivered later in 2014).
- For environmental impact, deliverable D9.5, "Environmental impacts of widespread shifting towards electricity based mobility" (to be delivered in November 2014).
- For consumer behaviour, Task 9.1 documents. In particular, deliverable D9.1 "Consumers' attitudes to, demand for, and use of EV" (to be delivered in September 2014).

The selection of the BMs to be analysed is based on the business scenarios defined in WP3 [D3.1] and the priority ranking they were given. In order to provide any service related to electric mobility, the charging service itself must be the first one to be considered. Under this BM (see **Figure 2**), an Electric Vehicle Service Provider (EVSP) offers charging services to its Electric Vehicle (EV) customers, and an Electric Vehicle Supply Equipment (EVSE) Operator offers such service to the EVSP (definitions can be found in section 0). This report presents the profitability assessment of such BM for the different stakeholders.

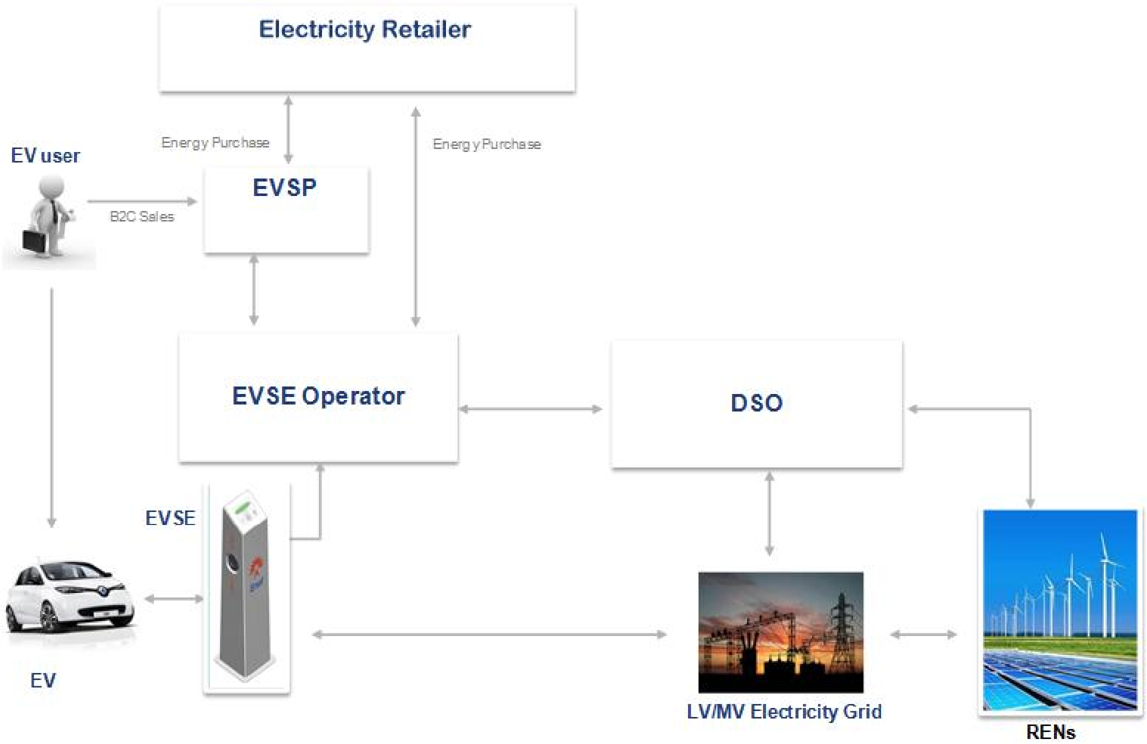

Figure 2: Green eMotion role model

EV-related BMs are networked business models, in which several actors interrelate with each other and all call for a positive business case. Therefore, the analysis considers the cost structure for the different stakeholders (including the payments to other participants in the ecosystem) and calculates the prices that each actor needs to charge to obtain a profitable BM. This way, the price that the final EV customer needs to pay is calculated and its total cost of ownership (TCO) is compared to the TCO of the owner of an internal combustion engine vehicle (ICEV), to see whether such price structure is sustainable in the long-term or whether public intervention is required.

This document also includes the definition of a set of key performance indicators (KPIs) which can be used by all users of the Green eMotion marketplace to assess the quality and effectiveness of e-mobility services provided through the system.

A set of performance indicators (PIs) developed from WP3 was the starting point for the definition of the KPIs in the categories of 1) Cost 2) Time 3) Quality of Service (QoS) and 4) Service Performance. Additional KPIs were added for the workable information and communication technology (ICT) system and were selected to support all user levels. These PIs and KPIs are intended to allow for the measurement and reporting of key aspects of system and service performance both within an ICT and business context. In addition, they will facilitate the assessment of the suitability of various BMs for use in both the ICT marketplace and across geographical borders through the CH concept. The cost, operational and roaming KPIs from the BMs are mapped on to the Green eMotion building blocks.

2.2 Green eMotion and Business Models Analysis

Although there is no common definition for the term *business model*, in general, a BM describes the rationale of how an organization creates, delivers and captures value [Osterwalder 2010]. Therefore, a BM should look into many aspects of the business developer and its environment, including customers, offer, infrastructure and financial viability.

In Green eMotion, the aim of the BM analysis is to identify the BMs most suited to facilitate large-scale EVs roll-out in terms of social acceptance, commercial viability and system/environmental impact. However, EV-related BMs are networked business models, in which several actors interrelate with each other and all call for a positive business case [EGVI 2012].

As a result, although the BM canvas proposed by [Osterwalder 2010] will be considered, the analysis, instead of focusing on how a single company can make money, will look at the BMs through which a company can make money and assess the impact that such BM has in the rest of market participants.

The different connections between the different actors are presented in **Figure 3**.

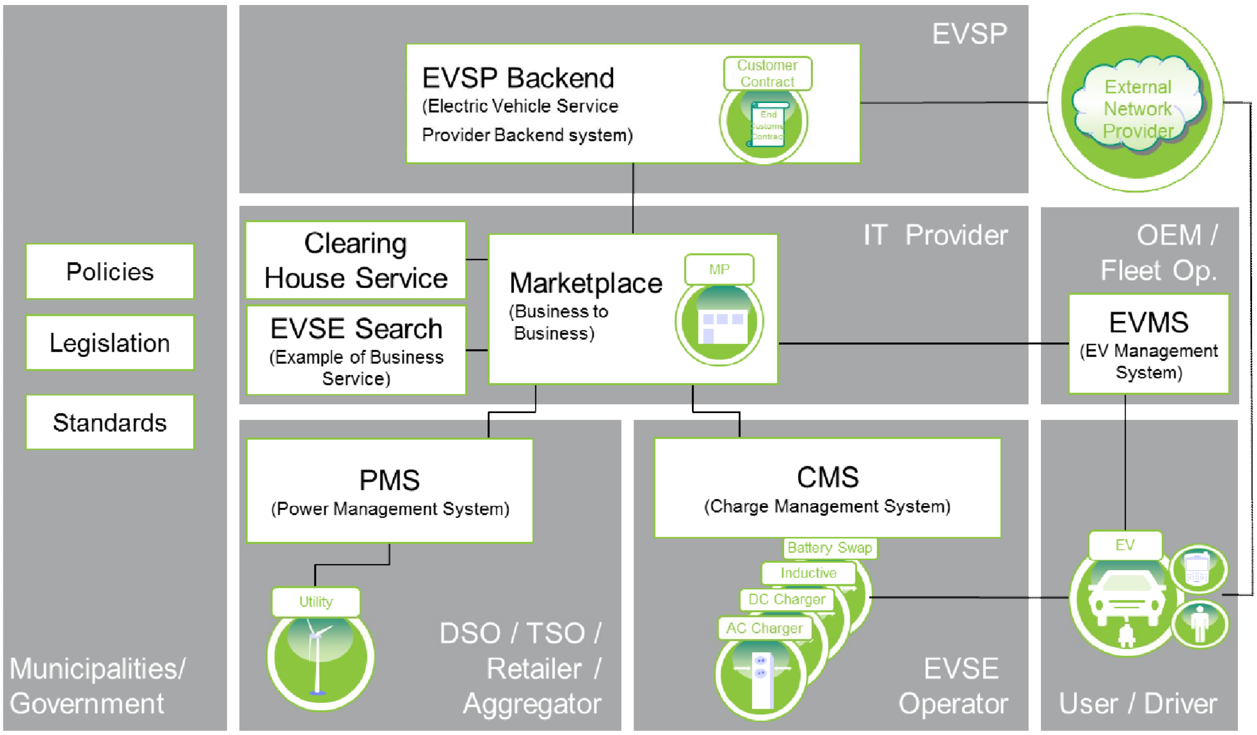

Figure 3: Green eMotion Building Blocks and Swimlanes

The analysis of networked BMs through traditional methods may result either time-consuming, or oblige to perform simplifications that usually hide important implications of the business for some of the involved actors. In order to overcome such problems, the e^{3}value methodology (see [e3value] and Annex I: Other methodological considerations) was created and adapted to the world of distributed generation and other Distributed Energy Resources (DER) (see [BUSMOD]). The main focus of e^{3}value is the assessment of all economic transactions between the different actors taking part in a BM. Therefore, the methodology focuses on the concept of economic value. In addition, the business cases are represented graphically, showing all the actors which are needed to run the BM (including the business developers, regulated actors and competitors) and the economic relationships between them. This way, all parties involved will have a shared understanding of the business case. When multiple cases are explored, they become comparable, and the most promising cases can be selected for further analysis.

In order to be as generic as possible and not to create very condensed models, the actors presented in e^{3}value models correspond to archetypal roles. Then, depending on national regulatory or market conditions, each "real" actor can play one or several of the roles presented in the models.

In Green eMotion, a number of BMs for e-mobility infrastructure and services are analysed and compared. The proposed BMs were chosen so that their results provide as much quantifiable information as possible. In each of them, the money exchanges between the different participants are calculated on the basis of the figures created with the e^{3}value methodology. Then, additional costs are considered for the key stakeholders, so as to calculate their annual cash-flows. Once annual cash-flows are obtained, an investment analysis is carried out to check the profitability of the investments they need to perform. Then, through a scenario building approach, the business opportunities for the different players can be assessed. In this converging process, all eventual scenarios that could be of potential interest for the EV deployment are carried out.

In short, the BM analysis is composed of the following main steps:

1. Selection of the business cases to be analysed (see section 2.4).
2. Graphical modelling of the selected cases, based on the e^{3}value methodology (see section 2.5).
3. Specification of the economic assessment tool (see Chapter 3).
4. Economic assessment (see Chapter 4).
5. Summary and discussion (see Chapter 6).

2.3 Main participants

The BM analysis does not only focus on the EV customers and on the actors who want to launch the business e.g. EVSE Operator or EVSP; it also looks at the impact on the different players across the whole value chain, including some regulated companies (such as TSO, DSO or EMO) and liberalised stakeholders (such as electricity retailers or producers). In this document, the definitions below will be used (more details can be found in the references included in each definition):

- EVSE Operator: [ISO_IEC 15118] defines an EVSE as “conductors, including the phase(s), neutral and protective earth conductors, the EV couplers, attached plugs, and all other accessories, devices, power outlets or apparatuses installed specifically for the purpose of delivering energy from the premises wiring to the EV and allowing communication between them as necessary. For this purpose the EVSE may also include communication to secondary actors”. The company owning or managing the recharging infrastructure and giving access to the distribution grid is the EVSE Operator.
- EVSP: According to the concept of e-mobility Operator, as defined by [ISO_IEC 15118], the EVSP is the “legal entity that the customer has a contract with for all services related to the EV operation”. Therefore, an EVSP offers e-mobility services to EV customers, so that they can recharge their EVs, including the roaming service (eventually at any EVSE across Europe), or benefit from additional services while driving/charging. This provision of services, including the EV charging services (either at home, at work or at any other public parking location), is the feature that characterizes the EVSP.
- EV customers: According to [EURELECTRIC 2013], the “e-mobility customer is a party that consumes e-mobility services using an electric vehicle, including electricity and charging services”. By considering the EVSP definition in [ISO_IEC 15118], EV customers are the parties who sign the contract with the EVSP. Likewise, EV customers also fall within the definition in [ISO_IEC 15118] for driver: “Person or legal entity using the vehicle and providing information about driving needs and consequently influences charging patterns”.
- Clearing House (CH): Based on the definition in [ISO_IEC 15118], the CH is the entity mediating between two or more clearing partners to provide validation services for roaming regarding contracts of different electricity providers. In the context of Green eMotion [Fricke 2012], the CH provides a couple of services which enable roaming: the contractual clearing and the financial clearing, which can be on top of the contractual clearing. EVSE operators can ask for validation of EV customers (contract clearing) and forward the Charge Detail Record (CDR)

so that the corresponding EVSP pays for the charging session (financial clearing). EVSPs can register, update and delete new contracts of their customers via the marketplace. The business-to-business (B2B) contract information can be stored in the CH directly or in the marketplace, while the business-to-customer (B2C) contract information can be stored in the CH directly, in the marketplace, or it can be requested each time from the corresponding EVSP.

- Marketplace Operator: The Marketplace Operator represents all administration activities performed by the marketplace. In the scope of Green eMotion ([D3.4], [Fricke 2012]), the marketplace is a virtual B2B environment for e-mobility related services, accessible through the internet and hosted in a cloud environment. Participants in the marketplace are parties which operate a business in the area of e-mobility and, hence, end customers do not have direct access to the marketplace, even if they use services from marketplace participants who offer and access ICT services on the marketplace. All business partners in the ICT eco-system may offer their EV services on the marketplace, which can then be bought by any other business partner. EV services consist of four service categories: core services, CH services, basic end user services and value-added services. In addition, the Green eMotion marketplace offer additional functionalities such as authentication and authorisation, linking and aggregation of EV services, collecting transaction data, monitoring and reporting, and business analytics for all EV services routed through the marketplace. The EV services may be created and hosted at the marketplace, offer well-defined and preferably standardised service interfaces, and can be embedded in higher level services to provide additional functionality.
- Transmission System Operator (TSO): According to [DIRECTIVE 2009/72/EC], the TSO is a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long term ability of the system to meet reasonable demands for the transmission of electricity. In addition, the TSO is responsible for managing electricity flows on the system, taking into account exchanges with other interconnected systems. To that end, the TSO is responsible for ensuring a secure, reliable and efficient electricity system and, in that context, for ensuring the availability of all necessary ancillary services, including those provided by demand response, insofar as such availability is independent from any other transmission system with which its system is interconnected.
- Distribution System Operator (DSO): According to [DIRECTIVE 2009/72/EC], the DSO is “a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity”.
- Electricity Market Operator (EMO): According to [ENTSOE 2011], the EMO is the unique power exchange of trades for the actual delivery of energy that receives the bids from the BRPs (see definition below) that have a contract to bid. The EMO determines the market energy price for the market balance area after applying technical constraints from the TSO. It may also establish the price for the reconciliation within a metering grid area. As a result, the EMO is responsible for managing the wholesale electricity market and it will be the sole counterparty for all market transactions. Therefore, electricity market participants do not trade with each other, but through the EMO, so, somehow, it is as if the EMO “sells” electricity to retailers and “buys” it from producers. EMO activities might be paid by the producers, by the retailers or by both, and according to the amount of energy traded in the market.
- Electricity retailer: According to [EURELECTRIC 2013], Electricity retailers are “the present and future companies that hold licenses (or are active on the market – not all countries have licenses) to sell electricity that they produce themselves or purchase on the electricity markets to end users, with whom they have power contracts with fixed locations for the supply.

- Balancing responsible party (BRP): According to [ENTSOE 2011], it is "a party that has a contract providing financial security and identifying balance responsibility with the Imbalance Settlement Responsible of the Market Balance Area entitling the party to operate in the market". This is the only role allowing a party to nominate energy on a wholesale level[1].
- Service providers: they offer several useful value added services optionally available via the marketplace. This may include the current location of the driver, average amount of energy charged while parking, timetables of public traffic, tourist information or weather forecast, etc. Green eMotion project focuses on value added services which create additional revenue for the electric mobility infrastructure and/or foster green transport behaviour.
- Telecommunication Providers: The electric mobility system needs to be able to communicate in order to exchange information. This is often carried out wirelessly, e.g. over GSM or 3G. Therefore, infrastructure to enable the communication between the EV, the EVSE infrastructure (Charging Stations, Battery Switch Stations, etc.) and backend services need to be provided. Herewith, it becomes obvious that communication standards are crucial for a fully functional system, which enables access to any company that adopts the standard.
- Metering Operator: In [EURELECTRIC 2013], it is defined as "the party responsible for metering duties allowing a consumer to purchase electricity on the supply market through the distribution grid. In most countries the role is played by the DSO. The metering information is critical to enable pay-per-use payment models when considered for e-mobility".

2.4 Selection of the business cases

When selecting the business cases to be analysed, it must be reminded that the objective of Task 9.3 is the identification and development of the BMs most suited to facilitate large-scale EV roll-out. In all of them, the EV customer will be a key participant, since it will be the one actually buying the EV. Besides, the EVSE Operator, who will invest in the recharging infrastructure, and the EVSP, who will be providing value-added services for EV customers, will also be key actors. As stated above, in EV-related BMs, several actors interrelate with each other and all call for a positive business case. Hence, EV customers' total cost of ownership (TCO) and the BMs for the EVSE Operator and the EVSP are strongly correlated. A change in the fee to be charged by the EVSE Operator will influence the price to be charged by the EVSP to the EV customer for EV charging and, hence, customers' TCO. Likewise, as the TCO decreases, the number of EVs will increase and, thus, the number of potential EV customers for the EVSE Operator, so the fee for EVSE access can also be lower.

In addition, the mass roll-out of EVs needs the collaboration of some other actors, such as the DSO or the TSO, whose activities (and profitability) are strongly influenced by the electricity demand increase derived from EVs. If EVs are to be extensively adopted, all the actors involved in the EV environment must see a positive profitability and, thus, the BM analysis needs to assess the impact on all these actors too.

In order to facilitate these BMs, a CH is needed to rout these requests (e.g. request for availability and subsequent reservation) from the EV user, towards an EVSP backend, and to the supplier (e.g. EVSE Operator). In more advanced BMs, the creation of a marketplace will be very important so that service providers (such as EVSE Operators, eco-routers…) can offer their services and service requesters (EVSP…) can seek for the most appropriate services for their customers.

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[1] The meaning of the word 'balance' in this context signifies that the quantity contracted to provide or to consume must be equal to the quantity really provided or consumed. It is equivalent to 'Program responsible party' in the Netherlands, 'Balance Group Manager' in Germany and 'market agent' in Spain.

The selected BMs are based on the business scenarios with priority 1 (highest priority), as defined in [D3.1], and which are summarised in Table 1 below:

Category	ID	Business scenario	Priority
Smart charging (C)	C1	Charging a. at home/ b. semi-publicly / c. publicly	1
	C2	Differentiation of customer contracts, Service Level Agreement (SLA)-Check	2
	C3	Mono-directional control of charging	2
	C4	Bi-directional control of charging (V2G, V2H)	2
Service handling / management (S)	S1	Marketplace: buying, selling, routing	1
	S2	Service detail records for accounting and billing	1
	S3	B2B contract management	1
	S4	Service provisioning/registration/life cycle management	1
	S5	Standardization of interfaces, messages (for remote customer service)	1
	S6	B2B partner management	1
Roaming (R)	R1	Roaming both between EVSE operators and between countries/regions	1
	R2	Authentication (for all kind of services) -> contract	1
	R3	Validation of contracts (from, to, scope, tariff info, ...)	1
OEM (O)	O1	Core driver scenarios (best charging, reservation)	1
	O2	Additional value added services (analytics and reporting, eco-routing)	2
	O3	Innovative services (advanced charging, maintenance)	3
Energy (E)	E1	Grid related value added services (Congestion management)	1
	E2	Energy trading value added services (VPP, imbalance)	2
	E3	Energy retail value added services	2

Table 1: Summary of business scenarios defined in WP3

From consumers' perspective the business scenarios C1b, C1c, R1 and O1 are relevant and are expected to meet customer's willingness to pay for these services. On the contrary, functions like authentication and authorization (category R) are a prerequisite for the operation of an EV, but there is no stand-alone business case for these basic services. However, these features are part of other business scenarios and, if a cost impact occurs, have to be included in the value chain.

In the context of the CH, the business scenarios S1 to S3 seem to be a "core function" and should be combined to one business idea of a CH.

Hence, the BM should consider the business scenarios of charging outside home, with roaming, using the marketplace and the CH, offering the possibility to get services as best charging or reservation and the provision of grid-related value added services.

On the other hand, different market models will be possible; in particular, depending on the roles played by the EVSE operator (even if the EVSP will be offering the same service to EV customers, the EVSE operator role can be played by the EVSP itself, by the DSO or by an independent company). A market model describes the market for charging infrastructure and the services provided by the infrastructure, including necessary regulatory elements. In addition, it represents the different interactions among the various players, defined according to their roles, under the given economic market forces.

The choice of one or another market model will most likely depend on the legal and regulatory conditions existing in each country. In the short term, different combinations of these arrangements can coexist in a single country but, in the long term, it is expected that there will be a preference for one single option. [EURELECTRIC 2010] defined a number of market models, which were further developed in [EURELECTRIC 2013].

These models will be used in this report, although their names will be changed because, in our opinion, these names give a better understanding of the actor performing the EVSE Operator role. Table 2 presents the different market models proposed by Eurelectric, the actors performing the different roles and the names to be used in this report.

Market model (Eurelectric)	Electricity distribution	EVSE ownership and/or operation	Provision of e-mobility services	Name in D9.4
Independent EVSP	DSO	EVSE Operator + EVSP		EVSP as EVSE Operator
Separated infrastructure	DSO	EVSE Operator	EVSP	Independent EVSE Operator
Integrated infrastructure	DSO + EVSE Operator		EVSP	DSO as EVSE Operator

Table 2: Market models for the roll-out of electric vehicle public charging infrastructure

If an EV customer, having a contract with an EVSP for charging services, is able to charge at an EVSE via a B2B roaming agreement between his EVSP and the operator of that EVSE[2], a roaming scenario occurs. [EURELECTRIC 2013] defined two roaming scenarios, depending on the way in which the electricity supplier is selected:

1. “Roaming of charging service”: The electricity retailer is chosen by the EVSE Operator, which sells the charging service (including electricity) at a given price condition to the EVSP. Hence, the electricity retailer is fixed at the charging station. In general, this scenario is more likely to happen in market models where the DSO is not the EVSE Operator, especially in the independent EVSP model (EVSP as EVSE Operator).
2. “Roaming of electricity and service”: The consumed electricity is purchased from an electricity retailer chosen by the EVSP. The B2B settlement, between the EVSP and the EVSE Operator, does not include the price of electricity. This scenario is usually linked to the integrated infrastructure market model (DSO as EVSE Operator).

From the BM perspective, the main difference between both scenarios is the way in which the EVSE Operator charges the EVSP for grid usage. In the “roaming of charging service” scenario, the EVSE Operator offers a “Charging service” to the EVSP, which includes the costs of energy, grid access and infrastructure. On the contrary, in the “roaming of electricity and service” scenario, the EVSE Operator offers “Access to the EVSE”, which includes the costs of grid access and infrastructure. As a result, the difference between “Charging service” and “Access to EVSE” is the cost of the energy that needs to be bought to charge the EV.

Moreover, the roaming can be made through a B2B roaming agreement between the EVSP and the EVSE Operator, but also through a B2B roaming agreement between each of them and a central clearing

[2] When the EVSP is also the EVSE Operator, the roaming will happen when the EV customer charges at an EVSE not operated by its own EVSP.

actor (either a "pure" CH, or a Marketplace Operator, who offers access to more services than just contract handling and financial clearing). This way, market actors can reduce their contract handling costs, by having a contract with just one party (the central clearing actor), instead of having thousands of contracts (one with each EVSP or EVSE Operator).

Due to the number of potential alternatives in each BM, the more generic market model (the independent EVSE Operator) is selected. Likewise, one of the main contributions of Green eMotion to the State of the Art is the concept of the Marketplace, so neither the bilateral contracting, nor the "pure" CH cases are considered.

Therefore, the BMs considered in this analysis are the following:

- BM 1 – Basic charging: An EVSP will offer recharging services to EV customers. In this case, **the value proposition is that the EVSP offers EV charging to EV customers who need to charge their vehicles**: EVSEs are bought and installed by an independent company, the EVSE Operator, who gives access to them as long as the EVSP pays a usage fee. The EVSP may buy the whole charging service from the EVSE Operator (roaming of charging service scenario) or just the access to the EVSE (roaming of electricity and service scenario). EV customers charge at an EVSE operated by an EVSE Operator who does not have a roaming agreement with their EVSP, but who has a roaming agreement with a Marketplace Operator with whom their EVSP has a roaming agreement too.
- BM 2 – EVSE Reservation: Once the EV market has been established, EVSPs can seek for new services, such as EVSE reservation, which can be provided by EVSE Operators. **The new value proposition is that EVSE Operators offer the possibility of reserving their EVSEs, which can be a valuable service for EVSP's EV customers**. EVSEs are bought and installed by an independent company, the EVSE Operator, who gives access to them as long as the EVSP pays a usage fee. EV customers reserve an EVSE operated by an EVSE Operator who does not have a roaming agreement with their EVSP, but who has a roaming agreement with a Marketplace Operator with whom their EVSP has a roaming agreement too.
- BM 3 – Congestion management: Not all the potential BMs will have the EV customers as the final requesters for the services. In the case of congestion management, the DSO may seek for an EVSE Operator who can manage its EVSEs, in order to overcome grid congestions. In this case, **the new value proposition is that ESVE Operators offer the possibility of controlling the electricity outcome to the DSO, so that the DSO can solve congestions in distribution grids**. In addition, the EVSE Operator can offer payment (or a discount in the EVSE access fee) to the EVSPs (and these to their EV customers) if they agree to let the EV charge be controlled. It is assumed that the DSO will more easily identify the EVSE located in the area of the grid where there are problems and, hence, it will be more straightforward to contact the EVSE Operator than the EVSP directly.

2.5 Graphical models

The process to create the graphical models is described in detail in [IR 9.3.1], as well as in Annex I: Other methodological considerations. Since then, progress was made in the BM definition (based on the market models in [EURELECTRIC 2013]), the building blocks and swim lanes in **Figure 3** were adopted in Green eMotion and the country-specific relationships were removed from the figures.

The models in [IR 9.3.1] included actors and relationships belonging to both the "traditional electricity supply" and the "specific EV service provision". The traditional electricity supply part was based on the existing market and legal arrangements in Spain.

However, it must be taken into account the European nature of the project, which demands a generic, rather than a country-based, approach. In addition, the presentation of the traditional electricity supply increases the complexity of the models, but has no impact on assessing the profitability of EV services (including charging) for the main actors (EV customers, EVSP, EVSE Operator, DSO). Therefore, the traditional electricity supply part of the models has been replaced by a black box named “Traditional electricity system”.

As an example, such “Traditional electricity system” for Spain would be the one presented in **Figure 4** below and would replace the area shadowed in green in **Figure 5**:

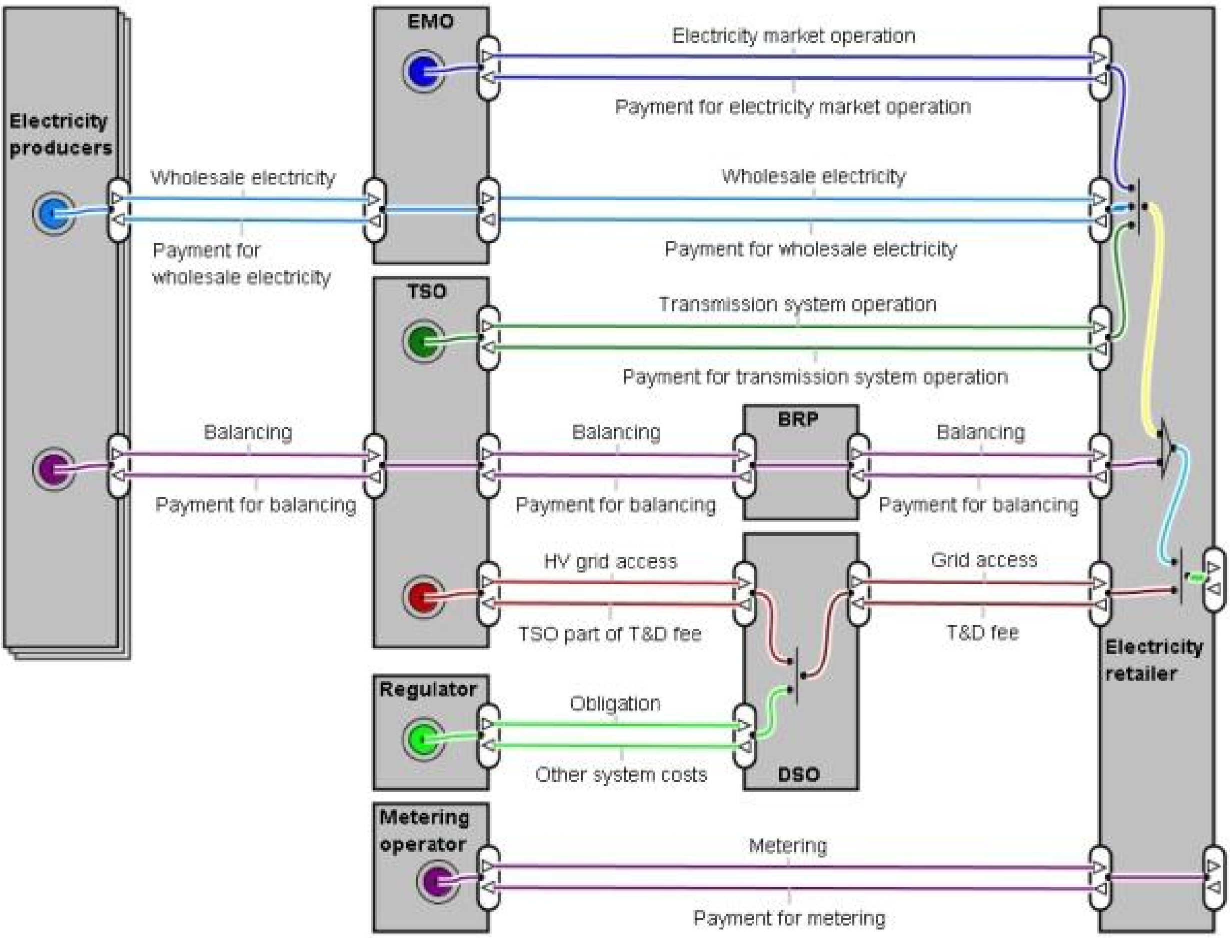

Figure 4: Example of “Traditional electricity system” for Spain

As stated in section 2.1, the analysis focuses on the Independent EVSE Operator market model, the roaming of charging service scenario and the contracting through the marketplace. Figures for other market models and roaming scenarios can be found in section 8.2 in Annex I: Other methodological considerations.

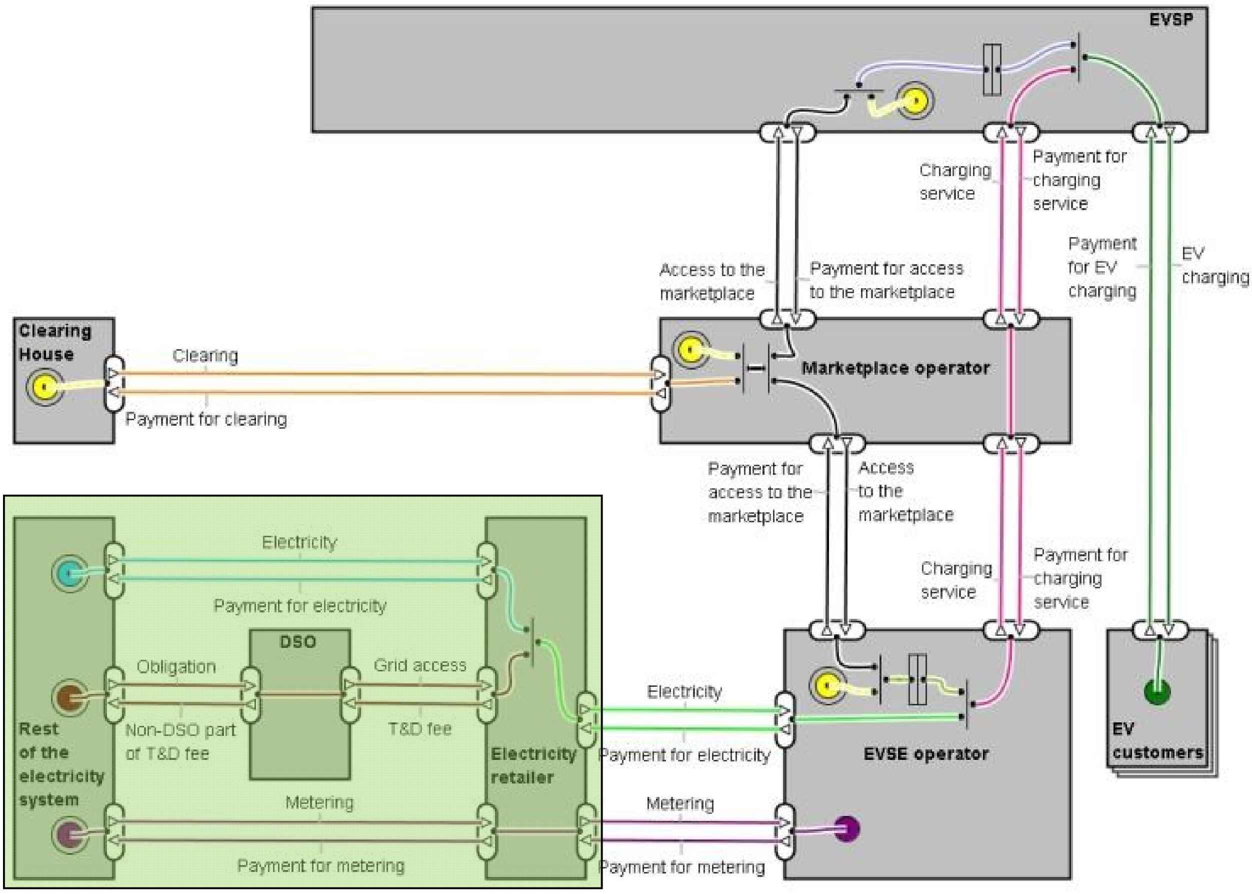

Figure 5: Model for BM 1, Independent EVSE Operator, Roaming of charging service, Marketplace

According to **Figure 5**, EV customers want to charge their EVs (green start stimulus), so they will pay for that to the EVSP. In order to satisfy such need, the EVSP needs to buy the charging service (pink lines) and, regardless of the amount of kWh (implosion in the violet line) it needs to pay for the communication (yellow end stimulus) and for access to the marketplace (black lines). The EVSP buys the charging service from the Marketplace Operator, who gets it from the EVSE Operator. The EVSE Operator must, on the one hand, buy electricity from the Electricity retailer (light green line) and pay, in each charging event (implosion), for the communication (yellow line and end stimulus) and for marketplace access (black lines), while on the other hand, it must pay for metering to the Electricity retailer (purple start stimulus), either if it consumes electricity or not (so a different scenario path is created for metering). The Marketplace Operator needs to pay for communications (yellow end stimulus) and for clearing to the Clearing House (orange lines). The Clearing House needs to pay for communications. The Electricity retailer must pay for grid access to the DSO (brown lines), for electricity itself (blue lines) and for metering (purple lines). The money exchanged required for this to happen depend on the market arrangements of each individual country (the ones for Spain are presented in **Figure 4**).

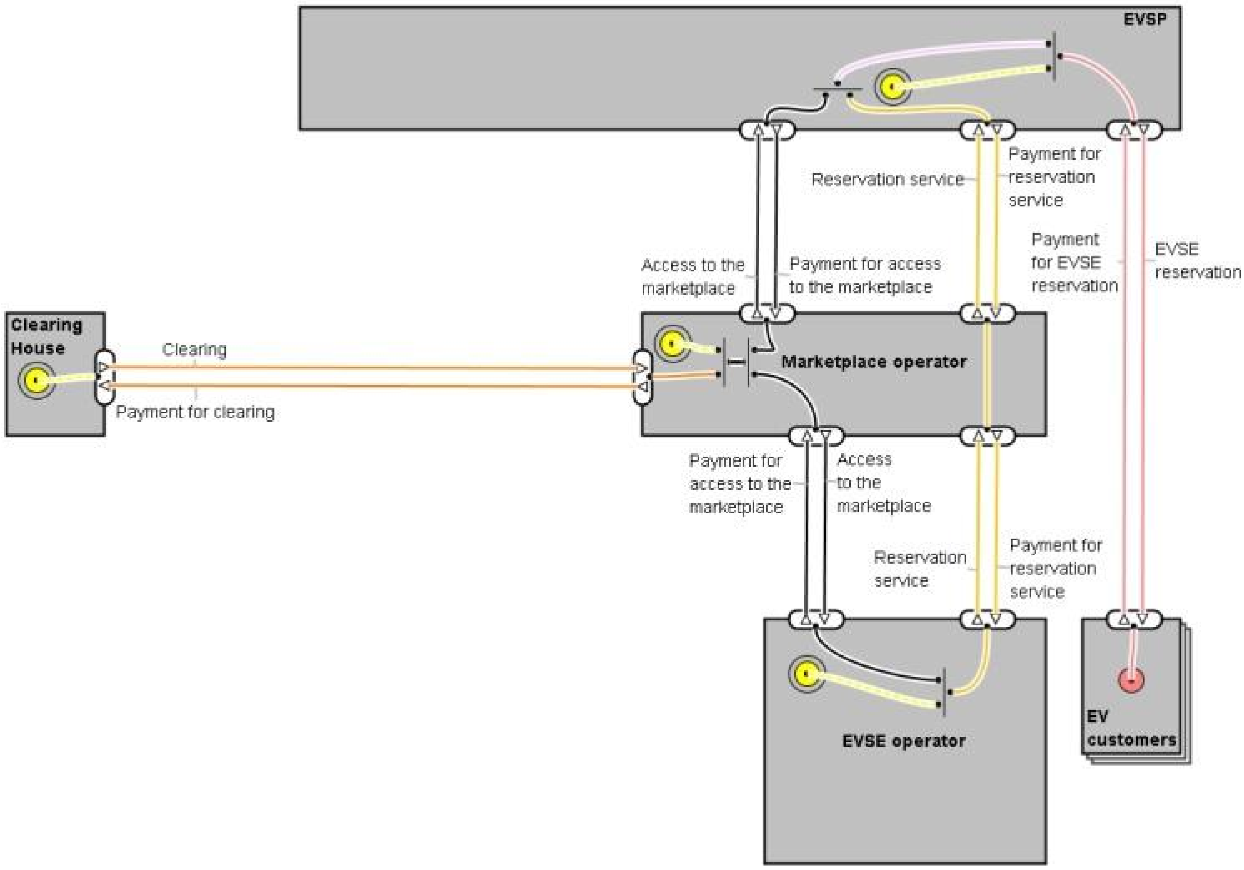

Figure 6: Model for BM 2, Independent EVSE Operator, Marketplace

In BM 2 (**Figure 6**), EV customers want to reserve an EVSE (pink start stimulus), so they will pay for it to the EVSP. The EVSP needs to pay for communication (yellow end stimulus), for the reservation service (light orange lines) and for the access to the marketplace (black lines) every time a reservation is made, so there is no implosion here. EVSE Operator receives the payment for the reservation service via the Marketplace Operator and needs to pay for accessing the marketplace (black lines) and for communications (yellow end stimulus). As in the BM 1, the Marketplace Operator, in order to provide its services, needs to pay for clearing (orange lines) and for communications (yellow end stimulus).

Regarding BM 3 (**Figure 7**), the need is in the DSO (light blue start stimulus), so it will need to pay for constraint management (aquamarine lines) on the basis of the number of kWh managed, and for accessing the marketplace (black lines) and communications (yellow end stimulus) every time it needs to solve a constraint (so an implosion exists). The Marketplace Operator forwards the payment for constraint management to the EVSE Operator, who will need to pay for access to the marketplace (black lines) and communications (yellow end stimulus) every time it sells a constraint management service (implosion), but also for the charge control service on the basis of the number of kWh (red lines). In this case too, the Marketplace Operator forwards the payment to the EVSP, who will need to pay for the access to the marketplace (black lines) and communications (yellow end stimulus) every time it sells the charge control service (implosion), as well as for charge control to EV customers.

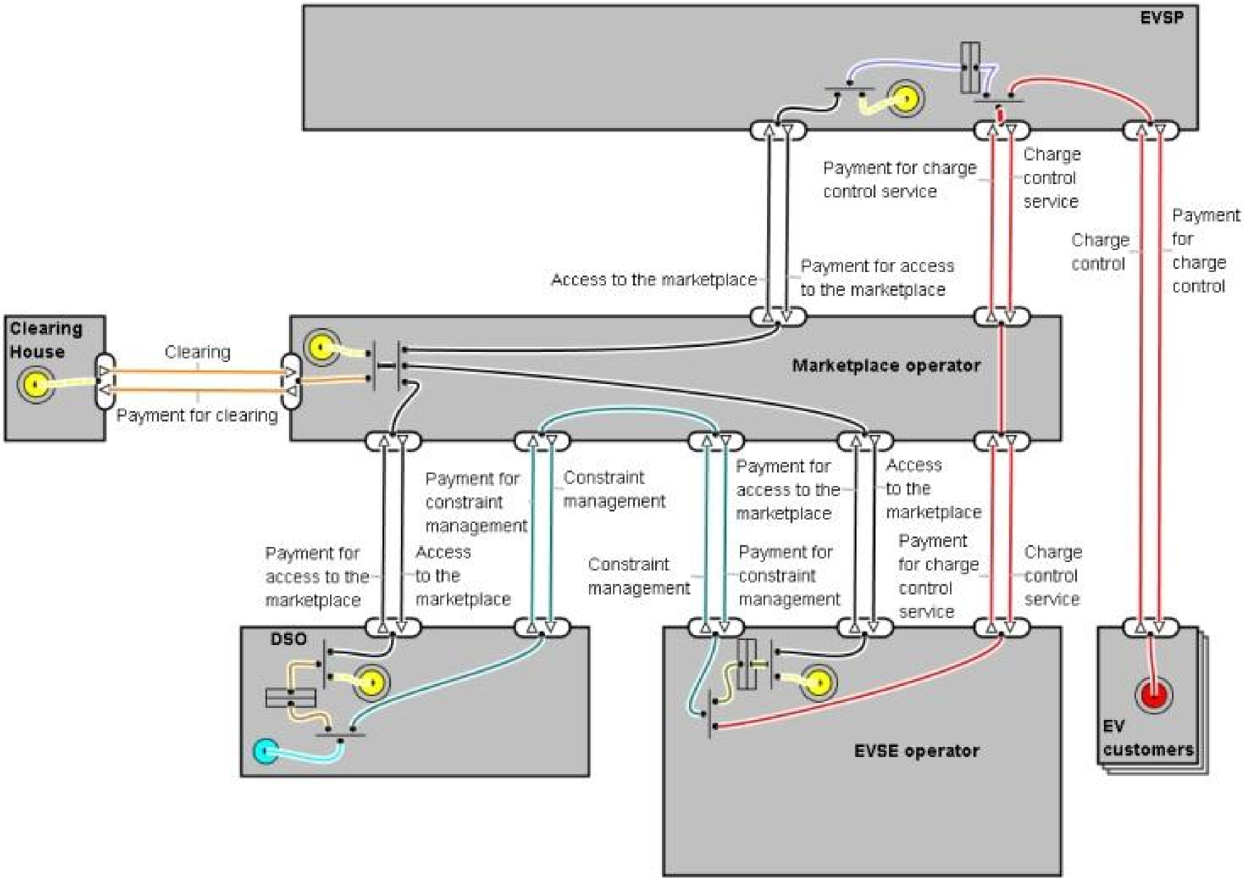

Figure 7: Model for BM 3, Independent EVSE Operator, Marketplace

2.6 KPI Definition for all user levels of the ICT architecture

Within the scope of this document is also provided a structured set of key performance indicators (KPIs) and performance indicators (PIs) which can be used by users of the Green eMotion marketplace to assess the quality and effectiveness of electric mobility services provided through the system.

This document draws heavily from the content of [D3.3] and [D3.4], which define the services and use cases (UCs) considered most likely to be delivered in demo regions as the market for electric mobility services matures. The information contained in [D3.3] and [D3.4] consists of extensive descriptions of the main services considered necessary or likely to feature in the marketplace in its first implementation. The 55 services are allocated to 114 UCs. These UCs are grouped into functional domains broadly covering those business cases defined in section 2.4 together with the rest of functionalities which must be offered to EV users in order to facilitate charging and travel throughout the European Union (EU).

Each functional domain listed in [D3.3] and [D3.4] was analysed on a UC level. A PI was defined for the primary actor(s) in each UC. This approach ensured that the performance indicators defined were relevant to the services employed and their context within the ICT system. The defined performance indicators are grouped into four categories (cost, time, quality of service and service performance) which address varying operational and business aspects that may be of interest.

In Chapter 5 of this report, a detailed description of the methodology used for the selection, description and specification of the PIs and KPIs for each UC has been included. The complete list of PIs and KPIs can be found in Annex II.

3 Business models economic assessment tool

The economic assessment tool will be used for assessing the economic impact of EVs roll-out on each actor involved, both directly and indirectly, in each BM selected.

It considers the relationships which must be taken into account, the data that need to be collected for making calculations and the formulas that will be used for them.

3.1 Tool objective

The objective is to assess the impact of the different BMs for all the relevant actors.

For that purpose, the tool will allow calculating the annual flows of funds for all the actors under analysis, based on the graphical models created through the e[3]value tool. These flows of funds will then be used as an input to calculate key actors' annual cash-flows, by considering all other expenses they will need for launching the BM. These expenses will include all company internal overheads and operational costs, such as client management systems or Radio Frequency Identification (RFID) card handling cost in the case of the EVSP, costs not directly related to charging and service for EV customers (to be reflected in a TCO model), and an increase in operational costs for the DSO.

Once annual cash-flows are obtained, an investment profitability analysis will be performed to check the profitability of the investments the different actors need to perform.

Since in most countries wholesale market prices can change every hour, annual cash-flows will be calculated adding hourly cash flows. Likewise, each actor's hourly cash-flow will be made up of all the in- and out-flows of funds in that hour. Such flows will be calculated from simple formulas, which represent the relationships between the actors.

Many of the financial parameters in a BM are difficult to estimate. Consequently, this analysis will identify the future steps which may strengthen or threaten the business case. Such events may influence valuations or even the structure of the value model itself.

3.2 Relationships between participants

As described in the graphical models in section 2.5, each business case will have different stakeholders, and the relationships between them will also be different.

Tables in this section present the relationships between the different stakeholders in each of the BMs selected, in the Independent EVSE Operator market model, the roaming of charging service scenario and when contracting through the marketplace. The relationships for other market models and roaming scenarios can be found in section 8.2 in Annex I: Other methodological considerations.

Each cell presents the object that the actor in the row pays to the actor in the column. For example, in Table 3, Electricity retailer pays *Metering* to the Metering Operator.

The flows of funds belonging to the "traditional electricity supply" do not vary with the BM under analysis, but strongly depend on the existing market, regulation and legal arrangements in each country. As an example, the exchanges in Spain are presented in Table 3[3].

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[3] The T&D payment by the retailer to the DSO, which is included in both figures, will be presented in next tables.

Pays \ to	TSO	BRP	EMO	Electricity producers	Metering Operator	Regulator
DSO	HV grid access					Other system costs
TSO	-			Balancing		
Electricity retailer	Transmission system operation	Balancing	Wholesale electricity / Electricity market operation		Metering	
BRP	Balancing	-				
EMO			-	Wholesale electricity		

Table 3: Relationships in "Traditional electricity system" in Spain

The relationships between the different stakeholders in BM 1 (see **Figure 5**) are presented in Table 4.

Pays \ To	EVSP	EVSE Operator	DSO	Electricity retailer	CH	Marketplace Operator	Communication provider
EV customers	EV charging						
EVSP	-					Access to the marketplace / Charging service	Communications
EVSE Operator		-		Electricity / Metering		Access to the marketplace	Communications
Electricity retailer			T&D	-			
CH					-		Communications
Marketplace Operator		Charging service			Clearing	-	Communications

Table 4: Relationships in BM 1, Independent EVSE Operator, Roaming of charging service, Marketplace

The relationships in BM 2 (**Figure 6**) are presented in Table 5.

Pays \ to	EVSP	EVSE Operator	CH	Marketplace Operator	Communication provider
EV customers	EVSE reservation				
EVSP	-			Access to the marketplace / Reservation service	Communications
EVSE Operator		-		Access to the marketplace	Communications
CH			-		Communications
Marketplace Operator		Reservation service	Clearing	-	Communications

Table 5: Relationships in BM 2, Independent EVSE Operator, Marketplace

EVSE reservation refers to the payment made by EV customers for reserving an EVSE, while *Reservation service* refers to the payment made by the EVSP to EVSE Operator (through the marketplace) for reserving an EVSE operated by the EVSE Operator.

The relationships in BM 3 (**Figure 7**) are presented in Table 6.

Pays \ to	EV customers	EVSP	EVSE Operator	CH	Marketplace Operator	Communication provider
EVSP	Charge control	-			Access to the marketplace	Communications
EVSE Operator			-		Access to the marketplace Charge control service	Communications
DSO					Access to the marketplace Constraint management	Communications
CH				-		Communications
Marketplace Operator		Charge control service	Constraint management	Clearing	-	Communications

Table 6: Relationships in BM 3, Independent EVSE Operator, Marketplace

Constraint management refers to the payment made by the DSO to the EVSE Operator for solving grid congestion, *Charge control service* refers to the service provided by the EVSP to the EVSE Operator (through the marketplace), so that the latter can help the DSO solve grid congestion, and *Charge control* refers to the payment made by the EVSP to EV customers for allowing to have a controlled EV charging.

3.3 Objects exchanged

Based on the relationships presented in section 3.2, the periodic flows of funds for each actor can be obtained by adding all the items in their column and subtracting all the terms in their respective row. For example, the cash-flow for the EVSP in BM 1 when charging through the marketplace (Table 4) will be:

$$CF_{EVSP} = \textit{EV charging} - \textit{Charging service} - \textit{Access to the marketplace} - \textit{Communications}$$

This section describes the way to calculate each of the objects exchanged by the actors.

3.3.1 EV charging

It is assumed that consumers pay for every charging event that they perform, on the basis of the amount of energy they demand (no flat rate or free charging considered). Under these assumptions, the earnings that EVSPs will receive for EV charging will be the multiplication of the charging price and the amount of energy charged by all its consumers. The EVSP asks for an EV charging price which may change every hour (see section 3.4). Therefore, the amount that the EVSP receives for *EV charging* from its *n* EV customers can be calculated, for each hour *h*, as:

$$\text{EV charging}_h = \text{EV charging price}_h * \sum_{x=1}^{n} \text{Energy demand by EV customer}_{x,h}$$

Where *n* is the number of EV customers serviced by the EVSP.

3.3.2 Charging service

In this analysis, the “Roaming of charging service” scenario will be considered, i.e. **it is assumed that the Electricity retailer is chosen by the EVSE Operator, which sells the charging service, including electricity, to the EVSP**. The charging service includes the costs of energy, grid access and infrastructure.

In order to be consistent with the assumption in subsection 3.3.1, where it is assumed that consumers pay for every charging event that they perform (no flat rate or free charging considered) and that the payment depends on the amount of energy charged, **it is assumed that the EVSE Operator asks for a payment every time a car in plugged in into its EVSE,** so the amount to be paid by the EVSP to the EVSE Operator for the charging service will be the multiplication of the charging service price and the amount of energy charged by all the consumers serviced by that EVSP.

Since the charging service price may change every hour (see section 3.4), the amount that the EVSE Operator receives for *Charging service* can be calculated, for each hour *h*, as:

$$\text{Charging service}_h = \text{Charging service price}_h * \sum_{x=1}^{n} \text{Energy demand by EV customer}_{x,h}$$

Where *n* is the number of EV customers serviced by the EVSP.

As the charging is made through the marketplace, this is the amount that the EVSP will pay to the Marketplace Operator, as well as the amount that the latter will pay to the EVSE Operator.

3.3.3 Retail electricity

The earnings that a retailer obtains for each charging event depends on the price of that electricity (which can be different in different hours of the day) and on the energy demanded by EV customers. Therefore, the income of the electricity retailer for *Retail electricity* can be calculated, for each hour *h*, as:

$$\text{Retail electricity}_h = \text{Retail price}_h * \sum_{x=1}^{n} \text{Energy demand by EV customer}_{x,h}$$

Where *n* is the number of EV customers serviced by the EVSP.

3.3.4 T&D fees

In EU Member States, the electricity supply is made up of the cost of electricity generation, the cost of electricity transmission and distribution, other costs of the electricity system and taxes [MOE 2012]. Although in some countries, the consumer may receive different bills from the retailer and from the DSO, the retailer sells electricity to consumers and pays for transmission and distribution (T&D) fees to the DSO in most of the cases.

The cost of T&D fees depends on the price of that fee (which can be different in different times of the day) and the energy demanded by EV customers. Hence, the amount to be paid for T&D in each hour *h* can be calculated as:

$$\text{T\&D cost}_h = \text{T\&D price}_h * \sum_{x=1}^{n} \text{Energy demand by EV customer}_{x,h}$$

Where *n* is the number of EV customers serviced by the EVSP.

3.3.5 Metering

Metering information is critical to enable pay-per-use payment e-mobility BMs. In this case, **it is assumed that the EVSE Operator pays a fixed monthly fee for metering**. Therefore, the amount to be paid for metering in each hour *h* can be calculated as:

$$\text{Metering}_h = \text{Number of EVSE} * \text{Metering price} * \frac{12 \text{ months}}{24 \text{ hours} * 365 \text{ days}}$$

Metering price is established as a fixed monthly payment, so it should be multiplied by 12 months and divided by 8760 hours in a year to obtain the hourly payment for metering.

3.3.6 Marketplace access

The different actors need to access the marketplace to exchange services. **It is assumed that participants pay for every access to the marketplace** (no subscription or free access considered). Marketplace access prices can be different in each hour *h* and for each participant *p*, so the amount that such participant will pay can be calculated as:

$$\text{Marketplace access}_{p,h} = \text{Marketplace access price}_{p,h} * \text{Number of accesses to the marketplace}_{p,h}$$

3.3.7 Clearing

As in the cases above, i**t is assumed that the Marketplace Operator pays for every clearing event** (no subscription or free access considered). Clearing prices can be different in each hour *h*, so the amount to be paid can be calculated as:

$$\text{Clearing}_h = \text{Clearing price}_h * \text{Number of clearing events}_h$$

3.3.8 Communications

In order to be able to exchange services with other participants, every actor needs to use some kind of communications. **The objective of this work is not to provide precise description of the communication system, but to consider them when assessing the economic performance of the BMs. In this case, it is assumed that each actor pays for every transaction it makes to the communication provider.** As a result, the communication paid by each participant *p* will be:

$$\text{Communication}_{p,h} = \text{Communication price}_{p,h} * \text{Number of communication events}_{p,h}$$

3.3.9 EVSE reservation

As in the case of the charging service, **it is assumed that consumers pay for every reservation they make and that the EVSE Operator asks for a payment every time an EVSE is reserved**. Therefore, the amount to be paid by EV customers to the for reserving the EVSE will be the multiplication of the EVSE reservation price (which may by different for each hour) and the number of times in which it is reserved by all the consumers serviced by the EVSP. So, for each hour *h*:

$$\text{EVSE reservation}_h = \text{EVSE reservation price}_h * \sum_{x=1}^{n} \text{Number of reservations by EV customer}_{x,h}$$

Where *n* is the number of EV customers serviced by the EVSP.

3.3.10 Reservation service

Likewise, the EVSE Operator will receive a payment from the EVSP that can be calculated, for each hour *h*, as:

$$\text{Reservation service}_h = \text{Reservation service price}_h * \sum_{x=1}^{n} \text{Number of reservations by EV customer}_{x,h}$$

Where *n* is the number of EV customers serviced by the EVSP.

Since the reservation is made through the marketplace, this is the amount that the EVSP will pay to the Marketplace Operator, as well as the amount that the latter will pay to the EVSE Operator.

3.3.11 Constraint management

As in the cases above, **it is assumed that the DSO pays for constraint management every time it needs to solve a problem in the grid**. Moreover, since constraint management is strongly correlated to the physical electricity grid, **it is assumed that the constraint management service is provided by the EVSE Operator**, who is the owner of the grid connection point. To be consistent with the assumption about EV charging (subsection 3.3.1), the DSO will remunerate the service on a per-kWh basis. The amount that the DSO will pay for the service can be calculated as:

$$\text{Constraint management}_h = \text{Constraint management price}_h * \sum_{x=1}^{n} \text{Energy managed by EV customer}_{x,h}$$

Where *n* is the number of EV customers serviced by the EVSP.

Since constraint management is made through the marketplace, this is the amount that the DSO will pay to the Marketplace Operator, as well as the amount that the Marketplace Operator will pay to the EVSE Operator.

3.3.12 Charge control service

In order to provide the constraint management service, **the EVSE Operator needs to be able to control the charging profile of EV customers**. However, EV customers only have a relationship with the EVSP, so **it is assumed that the EVSP offers the charge control service** and shares part of the incomes obtained with EV customers (e.g. as reduced EV charging price if EV customers allow charge control). The amount that the EVSE Operator will pay for being able to control the charge of the *n* EV customers serviced by the EVSP, in each hour *h*, can be calculated as:

$$\text{Charge control service}_h = \text{Charge control service price}_h * \sum_{x=1}^{n} \text{Energy managed by EV customer}_{x,h}$$

Since constraint management is made through the marketplace, this is the amount that the EVSE Operator will pay to the Marketplace Operator, as well as the amount that the Marketplace Operator will pay to the EVSP.

3.3.13 Charge control

The amount that the EVSP will pay to each EV customer *x* can be calculated, for each hour *h*, as:

$$\text{Charge control}_h = \text{Charge control price}_h * \text{Energy managed by EV customer}_{x,h}$$

3.3.14 Traditional electricity system

As stated in section 2.5, some flows of funds belong to the "traditional electricity supply", which does not depend on the BM under analysis, but on the existing market and legal arrangements in each specific country. As an example, Table 3 presents the relationships for the traditional electricity supply in Spain and the formulas to calculate the objects exchanged can be found below[4].

Although the DSO collects the T&D fees from retailers[5], part of the money received must be transferred to the TSO to pay for the investment in the transmission grid. The amount to be transferred is calculated on an annual basis, but it can be assumed that the hourly transfer is constant for the sake of simplicity. In this case, the money that must be transferred in any hour *h* is:

$$\text{HV grid access}_h = \text{T\&D share for the TSO} * \text{T\&D cost}_h$$

Likewise, T&D fees include some other costs that the DSO must transfer to the Regulator, such as the payments for feed-in tariffs to renewables and CHP, the cost of managing nuclear waste, etc. ([CNE 2012] provides the structure of costs for the Spanish T&D fees). As a result, the money that the DSO must transfer to the Regulator in any hour *h* can be calculated as:

$$\text{Other system costs}_h = (1 - \text{T\&D share for the DSO} - \text{T\&D share for the TSO}) * \text{T\&D cost}_h$$

Regarding the Electricity retailer, as already stated, **it is assumed that electricity is bought in the wholesale market, so the EMO will act as the sole counterparty for all market transactions.** Therefore, the retailer will pay for wholesale electricity to the EMO, and the EMO will pay for that electricity to Electricity producers. The cost of wholesale electricity depends on the price of that electricity (which can be different in different hours of the day) and on the energy that is expected to be demanded by the EV customers. Hence, the amount to be paid for wholesale electricity in each hour *h* can be calculated as:

$$\text{Wholesale electricity}_h = \text{Wholesale market price}_h * \sum_{x=1}^{n} \text{Energy demand by EV customer}_{x,h}$$

Where *n* is the number of EV customers serviced by the EVSP.

As stated above, the electricity supply is made up of the cost of electricity generation, the cost of electricity transmission and distribution, other costs of the electricity system and taxes. Other costs of the electricity systems include the regulated payments for transmission system operation and electricity market operation (all prices are established by the government):

$$\text{Transmission system operation}_h = \text{System operation price}_h * \sum_{x=1}^{n} \text{Energy demand by EV customer}_{x,h}$$

$$\text{Market operation}_h = \text{Market operation price}_h * \sum_{x=1}^{n} \text{Energy demand by EV customer}_{x,h}$$

Where *n* is the number of EV customers serviced by the EVSP.

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[4] Therefore, the formulas and the text in this subsection are country-specific. For example, in Germany the BRP has to pay for balancing energy (see last paragraph in this subsection) every time it does not meet the consumption announced on the day-ahead schedule.

[5] T&D fees are paid not only by EV customers, but also by any other electricity consumer in the system, but the modelling and analysis of such consumption is not the focus of this analysis.

In addition, the Electricity retailer will need to pay for metering to the Metering Operator. In this case, the amount to be paid will be the same as the one charged to the EVSE Operator (see subsection 3.3.5).

On the other hand, electricity balancing is one of the key roles of TSOs where they act to ensure that generation equals demand in real time [ENTSOE 2013]. In general, electricity balancing is composed of a reserve (the TSO allocates the availability from market participants to increase or decrease their electricity generation and/or consumption) and an actual balancing energy (the TSO dispatches the generation or consumption units, so that they increase or decrease their electricity generation and/or consumption). For the sake of simplicity, **only the balancing energy is taken into account** and it is assumed that **producers are remunerated when they provide upward balancing** (increase of electricity generation) and that **they must pay when they provide downward balancing** (decrease of electricity generation). As a result:

$$\text{Balancing Producers}_h = \text{Balancing price}_h * \text{Balancing energy}_h$$

According to this formula, the amount to be paid by the TSO is positive when producers provide upward balancing (positive balancing energy), but becomes negative if producers provide downward balancing (negative balancing energy) and, hence, the producers must pay for it to the TSO.

The amount of money that the TSO needs to pay or receives is then allocated to the parties which created the imbalance in the system. For simplification purposes, it is assumed that **only the Electricity retailer creates imbalances in the system**. In real world, there will be tens or hundreds of producers and retailers trading electricity in the market. Therefore, imbalances will not be created by a single party, but by many of them, but the modelling of all those agents in this analysis would dramatically increase its complexity, while it would not add much relevant information for the development of EV BMs.

Therefore, if **the Electricity retailer consumes less than expected the TSO pays for the difference** and w**hen the retailer consumes more than expected, it needs to pay that energy amount**. In this case, the payment from the retailer to the BRP will be the same as the payment from the BRP to the TSO, which can be calculated, for the hour *h*, as:

$$\text{Balancing BRP}_h = -\text{Imbalance price}_h * \text{Imbalance Retailer}_h$$

Again, the funds can flow in both directions: if the imbalance is negative (more electricity consumption than expected), balancing will be positive and, thus, the money will flow from the retailer to the BRP and from the BRP to the TSO. On the contrary, if the imbalance is positive (lower electricity consumption than expected), balancing will be negative and the money will flow on the contrary way, i.e. from the TSO to the BRP and from the BRP to the retailer.

3.4 Electricity prices

The development of EV market is just starting in most EU Member States, which try to regulate all the aspects related to electric mobility in the best possible way. However, each of them is taking its own steps and it is still unknown which regulation will prove to be more effective in the long term. In addition, each country has its own rules and conditions for participating in electricity markets, which makes it impossible to consider all the possible options as already discussed. Therefore, the electricity market regulation for Spain has been considered.

In order to simplify the calculations, instead of calculating hourly cash-flows for the whole series of 8760 hours, two typical days have been taken (one for winter and another one for summer) and hourly cash-flows have been calculated for each of the 24 hours in those days. For this calculation, “summer” means the period with the European Summer Time (from the last Sunday in March until the last Sunday in October each year, 217 days). The typical days (19th of both January and July) were taken so as they are in the middle of their seasons, in the middle of the month and in the middle of the week.

3.4.1 Regulated payments

As stated in subsection 3.3.14, the government established some fees that electricity buyers in the market must provide to the electricity market operator and to the system operator (which are added on top of electricity market prices, as presented in subsection 3.4.2). According to [MITYC 2011, 8] and [MITYC 2012, 1], each actor that buys electricity in the wholesale market must pay, for each MWh bought:

- Market operator fee: 0.0244 €/MWh.
- System operator fee: 0.0665 €/MWh.

On the other hand, the cost of single-phase meters for small consumers is 0.81 €/month (3-phase meters cost 1.15 €/month), set by [MITYC 2011, 4].

3.4.2 Electricity market prices

In Spain, market participants who buy electricity must pay not only for their market trade (in day-ahead or hour-ahead markets) but also for some other fixed system costs (such as the cost of the secondary control band[6], the capacity payments, etc.). [CNMC 2012] provides the final prices that different types of buyers in the market paid on average in Spain in 2012, as well as the components of those final prices.

Market participants must pay for the trade in the day-ahead and in the hour-ahead markets to the EMO, and for the rest of the items to the TSO. According to [OMIE], much more energy is traded in the day-ahead market, compared to the hour-ahead market (~228 TWh versus ~52 TWh in 2012), so, for the sake of simplicity, only the day-ahead market price will be considered.

On the other hand, the rest of the payments made by electricity buyers to the TSO are finally transferred to producers for the ancillary services they provided. Again, in order to simplify the calculations, no distinction is made between the different producers, so these additional payments made by the retailer to the TSO can be considered to be the payments for “Balancing”.

Therefore, the price for “Wholesale electricity” will be the day-ahead market price and the price for “Balancing” will be the difference between the final price[7] and the day-ahead market price. The market prices for the two typical days in 2012 are presented in Table 7, in €/MWh ([OMIE], [CNMC 2012]).

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[6] The secondary control band is an optional ancillary service with the objective of maintaining the generation-demand balance, correcting deviations with respect to the anticipated power exchange schedules between Spain and France, and frequency deviations. Its temporary action horizon stretches from 20 seconds to 15 minutes. This service is remunerated by means of market mechanisms via two concepts: availability (control band) and usage (energy) [REE 2013].

[7] The final price is the average price paid by market agents in a given hour, for their trade in the market. It includes the price in the day-ahead market, the price in the hour-ahead market, the price resulting from the process of solving the technical constraints in the transmission network, the price of the processes by the system operator (secondary band and both secondary and tertiary balancing) and the payment for long-term investments in power plants. It does not include the regulated payments in subsection 3.4.1, T&D fees and taxes.

Hour	Day-ahead price		Final price	
	Winter	Summer	Winter	Summer
1	60.24	51.02	68.55	60.36
2	53.13	43.00	61.68	52.95
3	48.00	40.05	55.71	48.55
4	43.74	35.53	51.73	44.66
5	42.76	35.53	50.86	44.43
6	46.00	40.06	54.34	48.71
7	49.68	42.74	60.53	52.20
8	62.71	51.02	73.68	60.60
9	63.00	54.02	76.89	64.38
10	63.30	56.52	76.03	66.25
11	61.10	57.50	73.33	69.49
12	60.24	57.00	72.34	69.56
13	61.89	60.00	73.65	73.23
14	62.74	60.24	73.40	74.57
15	62.56	57.02	73.09	68.71
16	60.42	56.60	70.74	68.00
17	60.42	56.07	70.81	67.35
18	64.15	56.10	75.33	67.51
19	68.00	53.50	81.75	64.80
20	69.35	51.02	84.39	63.88
21	68.00	49.50	82.95	63.65
22	68.79	48.57	81.68	62.58
23	64.52	49.50	75.38	62.86
24	58.59	45.50	67.66	55.51

Table 7: Market prices in two typical days in Spain (2012)

3.4.3 Retail prices for electricity

In Spain, there are three types of T&D fees (called access tariffs) for low-voltage consumers with a consumption capacity of up to 10 kW, depending on the number of periods and prices (see the references from [MITYC] and [MINECO]):

1. Tariff 2.0A: Flat tariff for the 24 hours of the day.
2. Tariff 2.0 DHA: Two-period tariff:
3. Tariff 2.0 DHS: Three-period tariff, specifically designed for EV charging.

These consumers are also the only ones for which the government establishes a regulated price (although retailers can offer lower prices). The structure of the regulated prices is the same as for the access tariffs, so there are regulated prices with flat tariff (corresponding to the 2.0A access tariff), with two periods (corresponding to the 2.0 DHA tariff) and with three period (corresponding to the 2.0 DHS tariff).

Both the regulated prices and the access tariffs can be updated by the government every three months[8]. The prices to apply in the typical days selected are presented in Table 8 (all figures in €/MWh):

Number of periods	Access tariff	Period	Access tariffs		Regulated prices		Horizon (CET)
			January	July	January	July	
1 period	2.0A	Flat	89.395	68.998	168.075	142.208	0:00-24:00
2 periods	2.0 DHA	Peak	125.153	96.598	208.833	172.518	13:00-23:00 (sum) 12:00-22:00 (win)
		Off-peak	4.470	3.450	62.260	60.780	Rest
3 periods	2.0 DHS	Peak	125.153	96.598	209.923	172.358	13:00-23:00
		Off-peak	6.258	4.830	74.608	70.440	Rest
		Super off-peak	2.235	1.725	51.735	54.405	1:00-7:00

Table 8: Regulated retail prices and access tariffs for electricity in Spain (2012)

For simplicity and to be consistent with the three-period tariff, the time horizon for the 2-period peak time will be considered to be from 13:00 to 23:00 in Central European Time (CET) both in summer and in winter.

According to [CNE 2012], the distribution of T&D fee incomes in 2012 was:

- DSO: 27.57%.
- TSO: 8.50%.
- Other system costs: 63.92%.

3.4.4 EV charging prices

Although the regulated access tariffs and retail prices have up to three price periods, the EVSP might offer different pricing alternative to EV customers. In particular, it is assumed that the EVSP can offer four pricing alternatives for EV charging:

1. Flat tariff: Same price for EV charging at any time of the day.
2. Dual pricing: More expensive EV charging in periods of peak electricity demand. The hours of both high-price and low-price periods are the same as in the two-period T&D fee (2.0 DHA).
3. Triple pricing: The price has three levels, according to the periods of the 2.0 DHS access tariff.
4. EV charging pricing with four-periods: The peak price period in the triple pricing option is divided into two different periods. The most expensive period has a price higher than the peak period in the triple pricing option, and the other three prices are about 10% (see Table 9) lower than the corresponding ones in the 3-period alternative.

[8] A new regulated pricing scheme was established in early 2014, where prices change every hour (for more details, see https://www.iberdrola.es/customers/home/regulated-rates/voluntary-princing-small-consumers), but the analysis presented here is made for 2012 and, hence, it considers the previous scheme, as described in this section.

In each of them, a regular EV charging price is considered, which is afterwards multiplied by a coefficient to get the EV charging price to be considered in each hour of the day. The coefficients for each hour in the different EV charging price alternatives are presented in Table 9.

Hour	Number of periods			
	1	2	3	4
1	1	0.55	0.65	0.59
2	1	0.55	0.48	0.43
3	1	0.55	0.48	0.43
4	1	0.55	0.48	0.43
5	1	0.55	0.48	0.43
6	1	0.55	0.48	0.43
7	1	0.55	0.48	0.43
8	1	0.55	0.48	0.43
9	1	0.55	0.65	0.59
10	1	0.55	0.65	0.59
11	1	0.55	0.65	0.59
12	1	0.55	0.65	0.59
13	1	0.55	0.65	0.59
14	1	1.63	1.61	1.45
15	1	1.63	1.61	1.45
16	1	1.63	1.61	1.45
17	1	1.63	1.61	1.45
18	1	1.63	1.61	1.92
19	1	1.63	1.61	1.92
20	1	1.63	1.61	1.92
21	1	1.63	1.61	1.92
22	1	1.63	1.61	1.92
23	1	1.63	1.61	1.45
24	1	0.55	0.65	0.59

Table 9: Coefficients for the profiles of EV charging prices

These pricing profiles have been created by taking the average differences between regulated retail prices in peak and the other periods and resulting in the same total cost for evenly distributed charging. The same procedure and the same profiles have been used for calculating the charging service price to be charged by the EVSE Operator.

3.5 Company overheads and operational costs

When performing the profitability analysis for the main actors, some other operational costs and overheads must be considered, in addition to the flow of funds identified in section 3.3. These overheads and operational costs include staff costs, facility related costs (including non-product related media/energy supply), R&D expenses not directly related to the product, marketing and communication, EVSE O&M costs and investments (some of which are related to the product and some of which are not).

In order to calculate staff costs, two approaches can be used:

1. For start-ups and SMEs, which are more appropriate for the present introduction stage of many e-mobility related services, a bottom-up approach can be chosen, where the needed resources have been estimated on the experience of the partners involved in the project.
2. For more mature markets, with very large number of e-mobility service customers, a benchmark approach with other sectors such as telecommunications or electricity retail business can be used, where staff costs and customer relationship management costs (CRM) can be calculated based on publicly available information, such as annual reports.

In this report, the first approach has been selected. For that purpose, 6 staff categories have been identified. For each of them, an average cost per person has been estimated, as well as the number of people required for different EV penetration scenarios.

Table 10 presents the data obtained from an internal Green eMotion workshop (17/06/2013) and the External Stakeholder Forum in Brussels (24/06/2013).

Actor		**Number of clients (up to)**							**Average costs**
	Category	*100*	*500*	*1,000*	*5,000*	*10,000*	*50,000*	*≥ 50,000*	*€/year*
EVSP	CEO	0	0	0	0	0	0	1	100 000
	Director	1	1	1	1	1	1	1	60 000
	Salesperson	1	1	2	2	2	2	2	30 000
	Technician	0	0	0	0	0	0	0	35 000
	Operator	5	5	5	5	5	5	5	25 000
	Administrative	1	1	1	2	5	5	10	20 000
CH / Marketplace Operator	CEO	0	0	0	0	0	0	1	100 000
	Director	1	1	1	1	1	1	1	60 000
	Salesperson	1	1	1	1	1	1	1	30 000
	Technician	0	0	0	0	0	0	0	35 000
	Operator	3	3	5	5	5	5	5	25 000
	Administrative	1	1	1	1	2	2	2	20 000
Actor		**Number of EVSE (up to)**							**Average costs**
	Category	*20*	*100*	*200*	*1,000*	*2,000*	*10,000*	*≥ 10,000*	*€/year*
EVSE Operator	CEO	0	0	0	0	0	0	0	100 000
	Director	1	1	1	1	1	1	1	60 000
	Salesperson	0	0	0	0	5	5	5	30 000
	Technician	1	1	1	2	3	6	6	35 000
	Operator	1	1	1	1	1	1	1	25 000
	Administrative	1	1	1	1	1	2	2	20 000

Table 10: New staff requirements and its costs (start-up and SME analysis)

For the communication company, the new staff requirements are assumed to be the same as for the CH / Marketplace Operator, but without CEO and directors.

The average costs presented in Table 10 correspond to estimates for Spain. In Germany, they are about twice as high, so the figures considered in the analysis should not be taken as a reference for an average EU country, as they might well be lower than the average EU-wide costs.

Overheads including cost for buildings/facilities and office equipment (including standard office IT) are expected to be around 20% of staff costs. In addition, there are some other costs that need to be considered, as presented in Table 11.

Actor	Additional costs
EVSP	EVSP IT backend, including: *Interface to the marketplace and/or EVSE Operator* *CRM system with billing engine (B2C billing)* Call-centre (B2C) / EV customer's portal Marketing and communication budget (B2C)
EVSE Operator	EVSE Operator IT backend, including: *Interface to the marketplace and/or EVSP* *Communication to EVSE* Call-centre (B2B) Marketing and communication budget (B2B)
CH / Marketplace Operator	CH / Marketplace IT systems, including: *development, operation and update of interfaces* B2B portal for EVSPs and EVSE Operators Call-centre (B2B) Budget for standardisation development Marketing and communication budget (B2B)

Table 11: Additional costs (start-up and SME analysis)

As a very first estimate, a value of 50% of staff costs is assumed for these expenses.

4 Economic assessment of the basic public charging

The results for the economic assessment of EV BMs depend on the boundary conditions chosen for the deployment of EV and the associated EVSE, as well as on the assumptions for the scenario to be assessed. In this chapter, in addition to the prices and costs presented in sections 3.4 and 3.5, the conditions presented in each section will be considered. For an easier reading of the document, the assumptions for each case are presented under the corresponding heading.

This first version of D9.4 presents the analysis for BM 1 (Basic charging), by taking into account the assumptions presented in section 2.1 (a change in which might have a significant impact on final results):

- Public and semi-public charging is considered (no private charging). Being the assistance to the European Commission (EC) one of the main goals of Green eMotion, the aim of this assumption is to analyse the economic performance of public charging infrastructure, so that this document can be used as an input for the discussions around the proposal for a directive on the deployment of alternative fuels infrastructure (for further details on the directive, see [EC]).
- AC slow charging (3.7 kW) is considered (no fast charging, inductive charging or battery swapping). This assumption lowers the fixed costs for EVSE Operator business (including grid connection costs) and can enhance its profitability even in low market conditions. Nevertheless, it is likely that EV customers will be asking for fast charging in public places (22kW or more), which is a topic that is worthwhile to be further investigated.
- Each role is played by independent actors. The market model considered is therefore completely unbundled: EVSE Operator, EVSP, Electricity retailer, DSO and TSO roles are all played by different actors (the separated infrastructure model in [EURELECTRIC 2010] and [EURELECTRIC 2013]). By considering this most generic case, the other market models can more easily be analysed, by merging the results of the different roles and taking into account the synergies existing in each case.
- The EVSE Operator selects the Electricity retailer and provides the charging service, including both the access to the charging infrastructure and the electricity to charge the battery (roaming of charging service in [EURELECTRIC 2013]). According to [D3.4], the goods traded through the marketplace are e-mobility related IT services, not physical goods (including electricity). Therefore, the roaming of electricity and service case requires that the EVSP obtains electricity from somewhere else, which makes the modelling more complex.
- The prices and the electricity market conditions for Spain are considered. Spain was selected for the availability and accessibility of data and because Spain is one of the top five countries in EV deployment requirements [EC 2013, 1]. Moreover, the biggest impact of this assumption is on the traditional electricity supply, which is out of the main focus of this analysis.
- The roaming between the EVSE Operator and the EVSP is made through a B2B marketplace (no bilateral contracting between them), according to the framework designed in Green eMotion.
- All the EV customers considered have a contract with the same EVSP and charge their EVs in the charging infrastructure of the same EVSE Operator (the impact of competition is not assessed). The BM analysis therefore assumes that the entire base of customers considered belongs to a single EVSP and a single EVSE Operator, which would mean that the market model (all actors independent) is implemented in one country having a monopolistic approach for EVSP and EVSE Operator. This assumption is not the expected market condition of an unbundled role model, but it was needed to be able to get the preliminary results presented in this report. This hypothesis also enhances the chance of profitability for business actors in low market conditions.
- There is no public intervention (no financial or regulatory incentives are considered for EV purchase, charging service fee discounts, EVSE deployment…).

- All EVs are full electric vehicles (no hybrid vehicles considered).
- Electricity trade is always made through the wholesale market (no bilateral trade of electricity), in spot markets (no futures/derivatives markets) and day-ahead (no hour-ahead trading).

However, the assumption that may have the strongest impact in the analysis is that all EV customers charge once per day in public, slow charging (see Table 12). As in the case of having a single EVSP and a single EVSE Operator, this assumption is very unlikely to happen in real-life, but an assumption was needed in order to get the preliminary results presented in this report. This assumption seems to overestimate the economic performance of the analysed business case. For example, if only 10% of the charges are made in public (each EV customer charges 0.1 times per day), EV charging price in the long-term scenario (see Table 13 below) would grow from 1.25 € to 7.91 €, making EV not able to compete with ICEV in economic terms and, thus, making the business case not sustainable.

These assumptions mean that, for example, if the average mileage of EV customers for the EVSE Operator to have a profitable business is 6 000 km/year, this mileage refers to the “public” mileage, i.e. the number of kilometres they drive thanks to the energy they charge in public or semi-public EVSE. If they also charge at home and the amount of energy charged is as much as the one charged in public or semi-public locations, the minimum mileage for the EVSE Operator to have a profitable business would be 12 000 km/year.

4.1 Base case

In the base case, the values presented in Table 12 will be considered.

Item	Value	Comments
Communication price (€/communication event)	0.01	Scenario definition
Number of charges per customer per day	1	
Type of Time of Use (ToU) tariff for electricity[9]	Flat	
Type of Time of Use (ToU) tariff for EV charging	Flat	
EVSE ratio per EV customer (EVSE/customer)	0.2	Based on [EC 2013,1]
Energy charged per charging event (kWh)	3	Based on [EC 2013, 3], [Brady 2013]
EVSE O&M costs (€/year)	500	Based on [NPE 2011]
EVSE lifetime (years)	10	
RFID card cost (€)	20	Based on [Zerowire][10] [Technovelgy]
RFID card lifetime (years)	20	
EVSE, RFID card, EV purchase discount rate	7%	Based on [Weitzman]
Average EV lifetime (years)	12	Based on [ACEA 2013]
EV consumption (Wh/km)	120	[EGVI 2012]

Table 12: EV charging conditions, constant values (BM 1, Base)

[9] Although the distribution of charges is the one for Scenario A in subsection 4.2.5., it is not presented here because it only affects the profitability of the Electricity retailer and Producers.

[10] The values in the reference do not consider handling and shipping costs, which are included in the 20 € considered for the analysis.

As stated in subsection 3.3.8, communication price refers to the price that each actor needs to pay for each communication event performed. In each charging event, the EVSP, the EVSE Operator, the Marketplace Operator and the CH will have one and only one communication event (see **Figure 5**).

Some other parameters are assumed to have an evolution in the next years. In order to assess the impact of such evolution, three scenarios have been defined for the short-term (ST), medium-term (MT) and long-term (LT)[11], as presented in Table 13:

	ST	MT	LT
Number of EV customers[12]	5 000	50 000	250 000
Number of EVSE	1 000	10 000	50 000
EVSE installation cost (€) [NPE 2011]	6 500	5 600	4 700
Civil work	*2 000*	*2 000*	*2 000*
Grid connection	*1 500*	*1 500*	*1 500*
Hardware	*3 000*	*2 100*	*1 200*
Add-on cost of an EV compared to an ICEV (€)	2 000	500	0
Purchase cost	*5 000*	*3 500*	*3 000*
O&M costs during the whole EV lifetime	*-3 000*	*-3 000*	*-3 000*

Table 13: EV charging scenarios (BM 1, Base)

The number of EV customers refers to both the number of EVSP's clients and the number of users of EVSE Operator's installation (no competition). In that sense, the study presented here is the best case for a given EV penetration. A brief introduction to the effect of competition can be found in section 4.2.

EV BMs are networked models, where lots of actors interrelate with each other and where the actions of each actor affect the feasibilities of the rest. For example, the price of communications has an effect on the feasibility of the CH and, thus, the clearing price will depend on its value. Likewise, the clearing price affects the Marketplace Operator's feasibility, so it will affect the marketplace access price, which has a further effect on the profitability of both the EVSE Operator and the EVSP, so the price of the charging service (the price requested by the EVSE Operator) will also be affected. Last, the price of the charging service affects the profitability of the EVSP, so also does the EV charging price (the price that EV customers must pay to the EVSP).

By using the parameters presented in Table 10, in Table 12 and in Table 13, and by setting the minimum desirable profit level for each actor at 10% of its annual expenditures (staff, overheads, O&M and annuitized investment), the minimum prices for the exchanged objects are presented in Table 14:

[11] All the references to ST, MT or LT in this report refer to the scenarios defined in Table 13 (or variations due to sensitivity analyses), not to any forecasts of what the situation may be in these time horizons.

[12] This is an assumption about a likely increase in the number of EV customers, partially based on the projections of [EGVI 2012]. It does not reflect an estimation of the potential EV market of Spain, or any other region, but only the expectation that the number of EV customers will strongly increase in the future. Its aim is to be used as a tool to calculate the economic performance of an EVSP and an EVSE Operator who have a growing portfolio of customers in an environment with decreasing EV-related costs.

Item	Payment from actor to actor	ST	MT	LT
Clearing price (€/clearing event)	Marketplace Operator → CH	0.22	0.04	0.02
Marketplace access price (€/access to the marketplace)	EVSE Operator → Marketplace Operator EVSP → Marketplace Operator	0.22	0.04	0.02
Charging service price (€/charging)	EVSP → EVSE Operator	1.71	1.33	1.20
EV charging price (€/charging)	EV customers → EVSP	2.20	1.42	1.25

Table 14: EV pricing scenario evolution in the three scenarios (BM 1, Base)

The cost components for the different years are depicted in **Figure 8**, **Figure 9** and **Figure 10**, by using the same colours as in figures in section 2.5 (in this case, **Figure 5**) for the different prices (orange, black, pink and green).

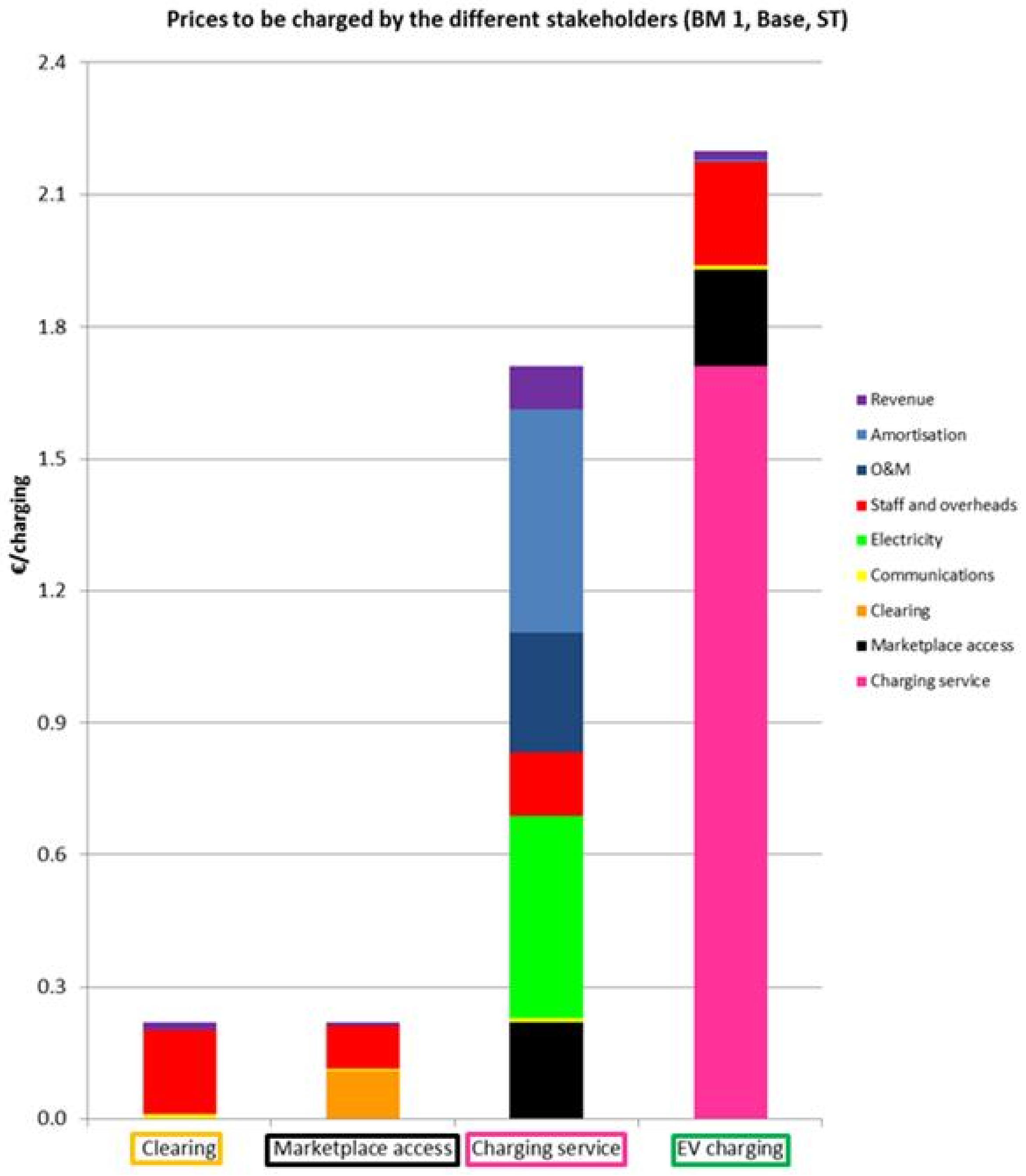

Figure 8: Components of the prices charged by different stakeholders (BM 1, Base, ST)

The marketplace access price is directly included in both the charging service and the EV charging prices (black areas), as both the EVSE Operator and the EVSP will need to pay for it every time a charging session happens. Likewise, the charging service price is also completely included in the EV charging price (pink area), as the EVSP will need to pay for it when charging is performed. However, as each charging session will result in a payment for marketplace access by both the EVSE Operator and the EVSP, and only one clearing will be needed, the marketplace access price only includes half the cost of the clearing price (orange area).

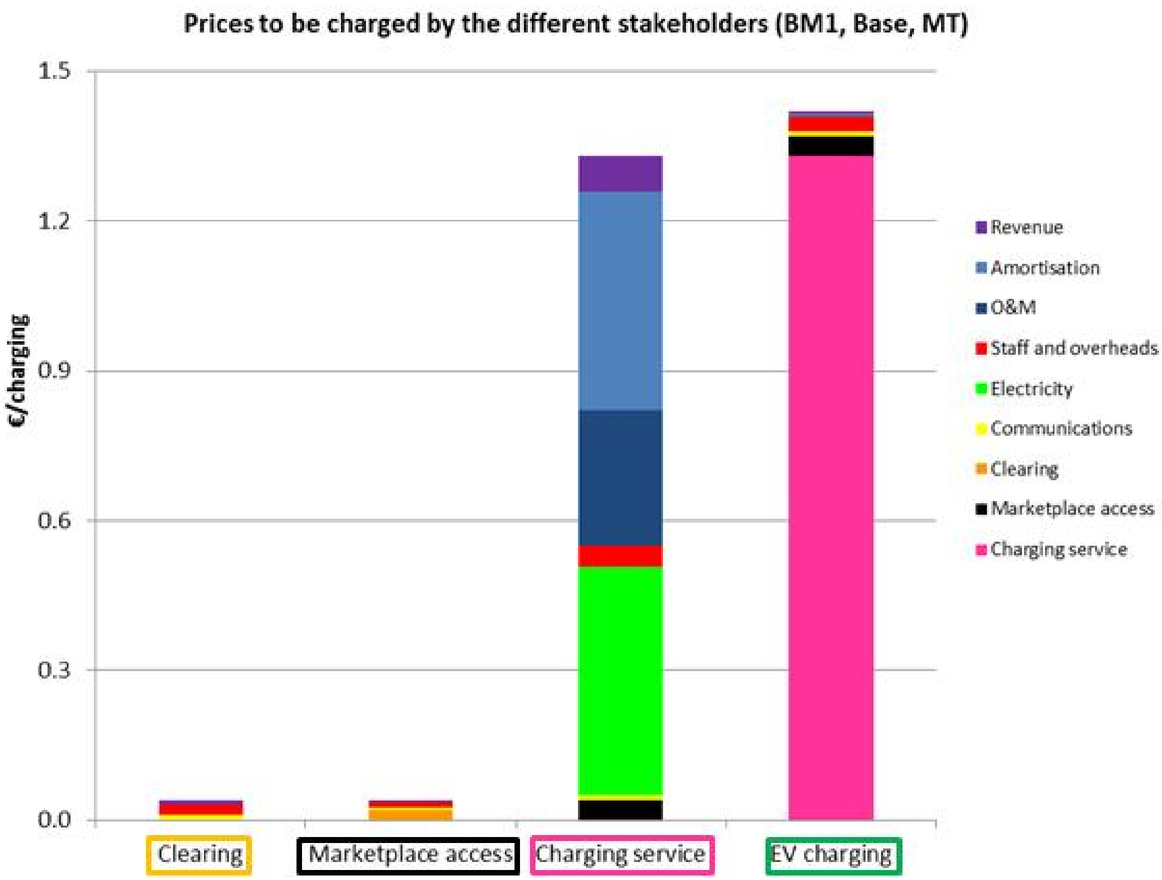

Figure 9: Components of the prices charged by different stakeholders (BM 1, Base, MT)

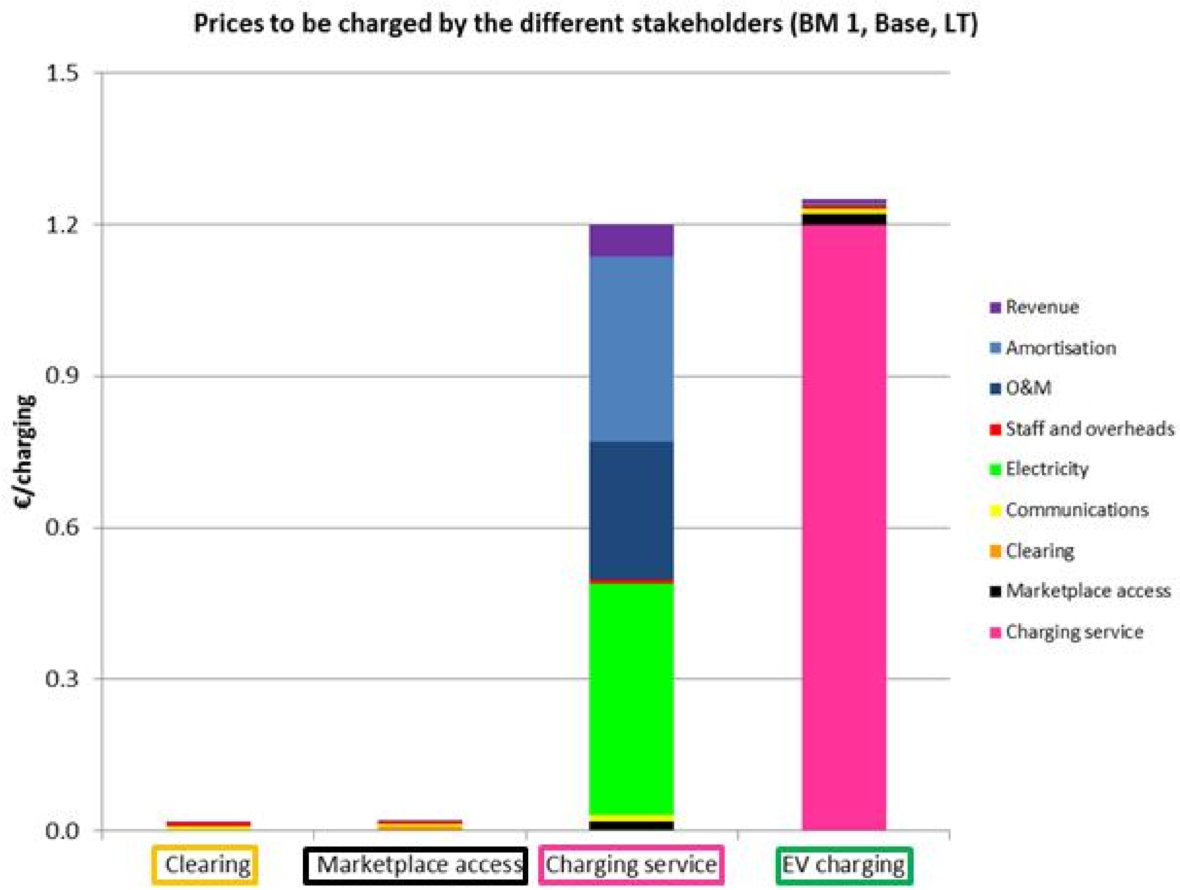

Figure 10: Components of the prices charged by different stakeholders (BM 1, Base, LT)

In all the scenarios, the main contributors to EV charging prices are the charging infrastructure itself and the procurement of energy, as **Figure 11** shows. In addition, as the number of EV customers increases from year to year, the relative weight of fixed costs (staff and overheads) is strongly reduced, leading to a situation in the long-term scenario where the purchase of electricity accounts for a third of the EV charging price, another third results from EVSE amortisation and almost a quarter of the price stems from EVSE O&M.

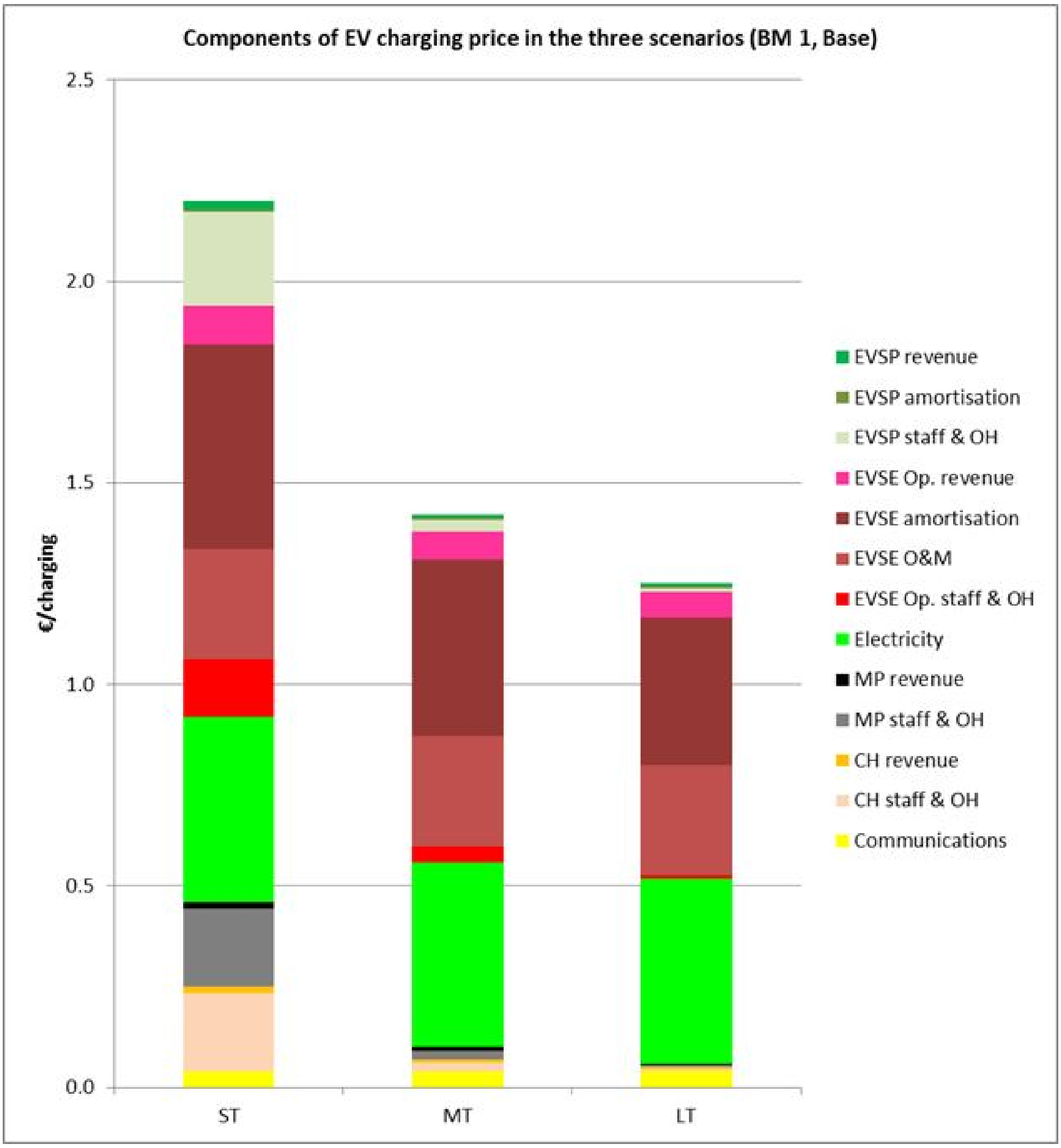

Figure 11: Components of the EV charging price (BM 1, Base)

Under these conditions, the results for the different actors in the short-term scenario are presented in Table 15 below (in €/year). It is important to bear in mind that the results for the traditional actors in the electricity industry (Electricity retailer, DSO, TSO, EMO, Producers…) only refer to the difference in profit resulting from having the EV customers charging electricity for their mobility needs.

Actor	Revenue	Staff costs	Overheads	O&M costs	EBITDA	Amortisation	Net
EVSP	474 500	285 000	142 500	0	47 000	9 439	37 561
EVSE Operator	1 864 581	175 000	87 500	500 000	1 102 081	925 454	176 628
Marketplace op.	383 250	235 000	117 500		30 750		30 750
CH	383 250	235 000	117 500		30 750		30 750
DSO	116 634	0	0	0	116 634	0	116 634
TSO	36 323				36 323		36 323
EMO	134				134		134
Regulator	270 453				270 453		270 453
Metering op.	405				405		405
Electricity retailer	32 651				32 651		32 651
Producers	379 819				379 819		379 819
Comm. provider	73 000				73 000		73 000

Table 15: Annual results for the different actors (BM 1, Base, ST)

By focusing on the EVSP, the EVSE Operator, the Marketplace Operator and the CH, the evolution of their net incomes in the three scenarios is presented in **Figure 12**.

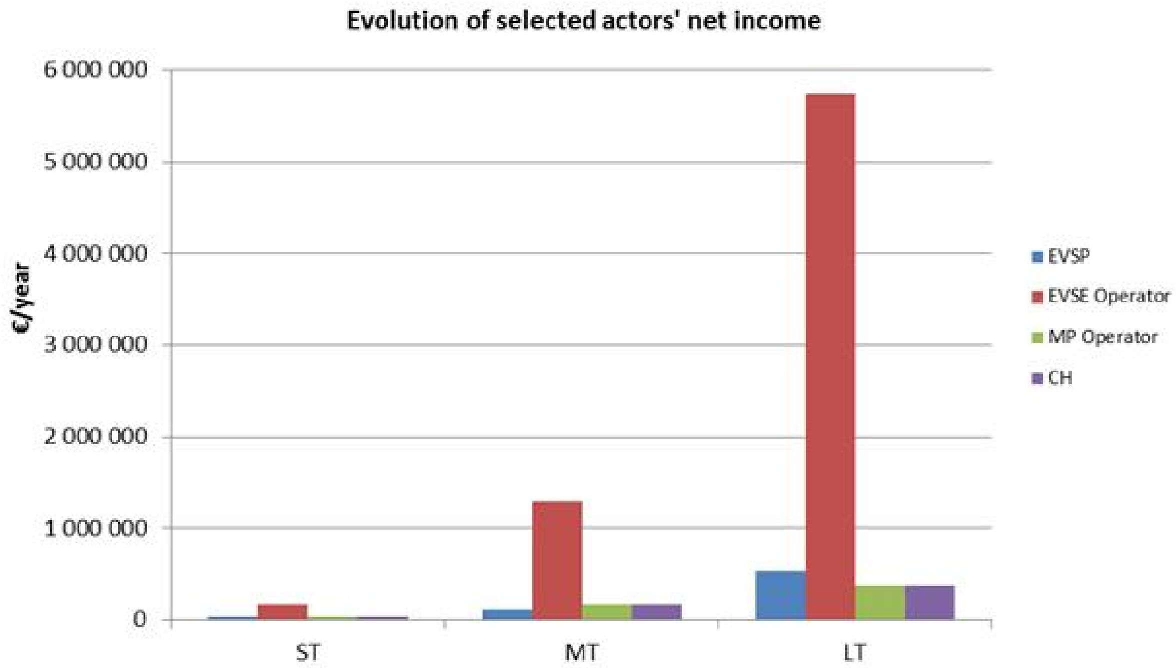

Figure 12: Evolution of selected actors' net income (BM 1, Base)

Business models become sustainable when, on the one hand, all the business actors recover their investments and make a profit (as shown in Table 15), and, on the other hand, the costs for EV customers are competitive with the costs of regular ICEV users.

According to Table 12, EV customers charge 3 kWh/day on average, so each of them would pay:

$$\text{Average electricity cost} = \frac{2.20\ €/\text{charging}}{3\ \text{kWh}/\text{charging}} = \mathbf{0.73\ €/kWh}$$

$$\text{Annual EV charging cost} = 2.20\frac{€}{\text{charging}} * 1\frac{\text{charging}}{\text{day}} * 365\frac{\text{days}}{\text{year}} = \mathbf{803\ €/year}$$

$$\text{Charging time cost} = \frac{2.20\ €/\text{charging}}{3000\ \text{Wh/charging}} * 230V * 16A * 1 = \mathbf{2.70\ €/hour = 0.045\ €/min.}$$

by assuming that charge is performed at 230V, 16A and cos φ = 1 (3.68 kW).

Even if the cost per kWh is much higher than the electricity price at home (between 0.14 and 0.17 €/kWh, see Table 8), it must be taken into account that EV customers must pay for the public infrastructure they are using (as they do e.g. when they order a drink at a bar and they pay four times as much as they would do at a supermarket). However, by looking at the price per time it is quite in line with the average price for public parking lots [Madrid 2014][13].

The average charge is 3 kWh, which, at 3.68 kW, takes about 49 minutes to complete. As there are 0.2 EVSE per EV customer and all customers charge once per day on average, each EVSE will serve 5 charges per day. Therefore, each EVSE would be used about 4 hours per day on average.

In order to compare the costs per 100 kilometres of EVs and ICEVs, both the operational and the capital costs must be taken into account. The 2015 fuel consumption target for ICEV is set to approximately 5.6 litres/100 km of petrol or 4.9 l/100 km of diesel ([ECCA]), while prices for petrol and diesel in the EU in August 2013 were 1.591 €/l and 1.446 €/l, respectively ([MITYC 2013]), which means about 8.91 €/100 km and 7.09 €/100 km for gasoline and diesel cars.

Assuming the same usage rate for an ICEV and an EV, the comparison of the mileage costs could neglect the cost of buying an ICEV (as it would increase both mileage costs in the same amount, while keeping the spread between them), and it could focus on the add-on cost for buying an EV (as shown in Table 13).

However, a real case has been considered in order to present the absolute values. In Spain, almost 40% of the new cars sold are segment B or segment C [Aniacam 2014]. In segment B, the top four models are Seat Ibiza, Volkswagen Polo, Opel Corsa and Renault Clio. The average price (including taxes) of these models in 2011 was about 13 500 € [EC 2011]. Since the same usage is considered for ICEV and EV, the same lifetime (12 years) and discount rate (7%) as the ones presented in Table 12 must be considered, which gives an annual amortisation of about 1 700 €/year:

$$\text{Annual amortisation of ICEV} = \frac{13\,500\ €}{\frac{(1+7\%)^{12}-1}{7\% * (1+7\%)^{12}}} = 1699.98 \sim 1700\ €/\text{year}$$

Likewise, the same mileage must be considered. According to Table 12, EVs charge 3 kWh every day and have an energy consumption of 120 Wh/km (0.12 kWh/km):

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[13] The aim of this document is not to give recommendations on how the different stakeholders should charge for their services (e.g. charge a fixed fee for each charging to recover some of the fixed costs, and then charge a price for the amount of energy, connection time or kilometres between charges), but rather to discover whether there are scenarios that create positive conditions for all the stakeholders. Therefore, average values will be considered for the portfolio of EV customers and the numbers presented will refer to the price to be charged to that average consumer. For an easier comparison, the EV charging price (the amount to be paid by EV customers to the EVSP), the charging service price (the amount requested by the EVSE Operator) and the mileage cost will be used.

$$\text{Annual mileage} = \frac{3\ \text{kWh/day*365 days/year}}{0.12\ \text{kWh/km}} = 9\ 125\ \text{km/year}$$ [14]

As a result, the mileage cost linked to ICEV purchase can be calculated as:

$$\text{Mileage cost linked to ICEV purchase} = \frac{1\ 700\ €/\text{year}}{9\ 125\ \text{km/year}} = 18.63\ €/100\ \text{km}$$

Therefore, the target mileage costs for gasoline and diesel cars in 2015 are 27.54 €/100 km and 25.72 €/100 km, respectively. These mileage costs are assumed to be constant in the three scenarios.

Regarding the EV, based on the purchase add-on costs and the O&M savings presented in Table 13, together with the lifetime and the discount rate presented in Table 12, the annual add-on amortisation cost of the vehicle would be 251.80 €/year, leading to a total amortisation cost of 1 951.80 €/year:

$$\text{Add-on annual amortisation of EV} = \frac{2\ 000\ €}{\frac{(1+7\%)^{12}-1}{7\% * (1+7\%)^{12}}} = 251.80\ €/\text{year}$$

Hence, the average mileage costs of EVs can be calculated as:

$$\text{EV mileage cost} = \frac{1\ 951.80\ €/\text{year}}{9\ 125\ \text{km/year}} + \frac{2.20\ €/\text{charging} * 0.12\ \text{kWh/km}}{3\ \text{kWh/charging}} = 0.3019\ €/\text{km} = \mathbf{30.19\ €/100\ km}$$

The components of mileage costs in the three scenarios are presented in **Figure 13**. In order to present the differences between ICEV and EV and to neglect the effect of having chosen one specific country and segment, the mileage cost linked to ICEV purchase is not presented completely.

As **Figure 13** shows, the impact of EV amortisation in the mileage cost difference in the short-term scenario is the highest one (accounting for a share even bigger than the EVSE amortisation cost). As technological development decreases EV add-on cost, its impact on EV customers' mileage cost is reduced.

It is however important to mention that customers do not only look at the economic performance when buying a new car. In the case of ICEV, other important aspects include fuel efficiency, safety, performance, warranty, style or the brand [Microsoft Advertising 2013]. In addition to these, driving range, top speed, battery life or carbon emissions are also important aspects that potential EV buyers take into account [Jensen 2013].

[14] This is the number of kilometres that EV customers can drive as a result of public charging. If they also charged at home (which is out of the scope of this document), their annual mileage would be increased.

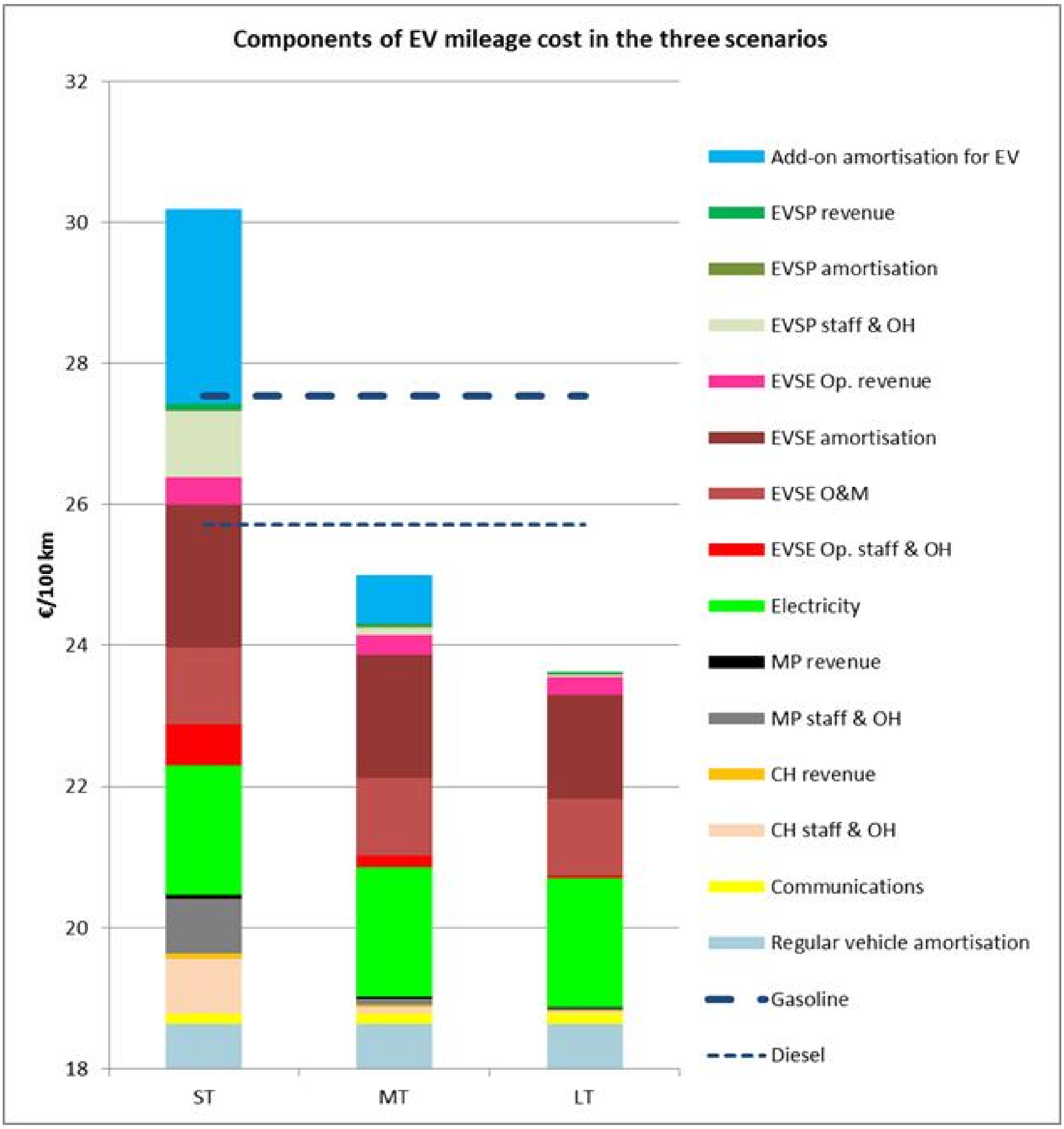

Figure 13: Evolution of components of EVs mileage costs (BM 1, Base)

Another alternative for designing the BM is that EVs become competitive with ICEV in the short-term scenario, and that different stakeholders accept some business losses, which can be compensated in the medium-term and long-term scenarios.

In order to make EVs competitive with ICEVs in the short-term scenario, the EV charging price should be set at 1.50 €/charging to compete with gasoline, which would give a mileage cost of 27.39 €/100 km (compared to 27.54 €/100 km of gasoline).

If losses are evenly distributed between EVSP, EVSE Operator, Marketplace Operator and CH, the prices that each of them needs to request are presented in Table 16.

Item	Gasoline
Clearing price (€/clearing event)	0.07
Marketplace access price (€/access to the marketplace)	0.07
Charging service price (€/charging)	1.32
EV charging price (€/charging)	1.50

Table 16: EV pricing conditions (BM 1, Base, Competitive with gasoline in 3 scenarios)

By considering that these prices are kept constant in the three scenarios, the evolution of net incomes for the different actors is presented in Table 17 below.

Actor	ST	MT	LT
EVSP	-254 439 €	1 213 107 €	7 835 535 €
EVSE Operator	-261 372 €	565 174 €	12 142 860 €
Marketplace Operator	-243 000 €	712 500 €	4 942 500 €
CH	-243 000 €	712 500 €	4 942 500 €

Table 17: Net incomes for main actors (BM 1, Base, Competitive with gasoline in 3 scenarios)

As Table 17 shows, actors could accept some losses in the short-term scenario, as they would be compensated in the medium-term and long-term scenarios, if the assumed technological development and EV deployment are fulfilled.

In the case of diesel ICEV, the target mileage cost would be 25.72 €/100 km, which means that EV charging price should be 1.10 €/charging in the short-term scenario. However, according to the assumptions made in the analysis, the minimum price that the EVSP should charge in the long-term scenario so that all the stakeholders have a profitable business is 1.18 €/charge. Therefore, EV charging price cannot be kept constant in the three scenarios.

Since EV add-on costs and EVSE hardware costs decrease in the medium-term and long-term scenarios, a profitable business scenario can be found for all the stakeholders, with the adequate pricing strategies. If the EVSE Operator accepts to have losses in the short-term and medium-term scenarios, the pricing evolution presented in Table 18 can be used.

Actor	ST	MT	LT
Clearing price (€/clearing event)	0.21	0.03	0.02
Marketplace access price (€/access to the marketplace)	0.21	0.03	0.02
Charging service price (€/charging)	0.64	1.17	1.20
EV charging price (€/charging)	1.10	1.25	1.25

Table 18: EV pricing evolution (BM 1, Base, Competitive with diesel in 3 scenarios)

Under these pricing strategies, on the one hand, EV mileage costs are 25.79 €/100 km, 25 €/100 km and 23.63 €/100 km in the three scenarios, which are competitive with 25.72 €/100 km. On the other hand, there is room for making a profitable business for main stakeholders, as presented in Table 19.

Actor	ST	MT	LT
EVSP	1 061	118 107	535 535
EVSE Operator	-1 757 872	-1 442 326	5 755 360
Marketplace Operator	12 500	-17 500	380 000
CH	12 500	-17 500	380 000

Table 19: Net incomes for main actors (BM 1, Base, Competitive with diesel in 3 scenarios)

The long-term strategy presented above needs to be carefully designed and the potential implications for real-life implementation need to be further investigated. For example, a coordinated action must be taken between the different stakeholders in order to get the pricing strategy to make EVs competitive with diesel ICEVs, which might not be easy to ensure in real-life conditions.

4.2 Sensitivity analysis

The parameters considered in the base case are based on existing literature, but enriched with the results of several workshops, meetings and phone conferences organised during the development of the task. Of particular interest were the workshops in Bilbao (November 2011), Brussels (June 2013) and Munich (June 2013 and February 2014), where different industrial partners provided their views about future businesses around electric mobility.

However, a sensitivity analysis is required, to check the effect that an evolution of the EV market, which might be different from the most likely one, might have on the results of the economic assessment performed for the base case. This way, the conditions under which there will be eventually a positive business model for everyone can be identified.

4.2.1 EV penetration

On the one hand, part of the costs included in the EV charging price to be satisfied by EV customers is related to the company running costs for both the EVSE Operator and the EVSP, which increase as the number of clients increases (see Table 10). On the other hand, as the portfolio of customers increases, the incomes also increase.

To check the effect of both increases on the value chain, a sensitivity analysis has been performed on this parameter, by considering the conditions in Table 20.

Item	Value
Communication price (€/communication event)	0.01
Number of charges per customer per day	1
Type of Time of Use (ToU) tariff for electricity	Flat
Type of Time of Use (ToU) tariff for EV charging	Flat
EVSE ratio per EV customer (EVSE/customer)	0.2
Energy charged per charging event (kWh)	3
EVSE O&M costs (€/year)	500
EVSE lifetime (years)	10
RFID card cost (€)	20
RFID card lifetime (years)	20
EVSE, RFID card, EV purchase discount rate	7%
Average EV lifetime (years)	10
EV consumption (Wh/km)	120

Table 20: EV charging conditions, constant values (BM 1, Sensitivity to EV penetration)

As in the base case, an evolution is assumed in the next years for some other important parameters, as presented in Table 21.

	ST	MT	LT
Number of EV customers	5 000	50 000	250 000
EVSE installation cost (€)	6 500	5 600	4 700
Civil work	*2 000*	*2 000*	*2 000*
Grid connection	*1 500*	*1 500*	*1 500*
Hardware	*3 000*	*2 100*	*1 200*
Add-on cost of an EV compared to an ICEV (€)	2 000	500	0
Purchase cost	*5 000*	*3 500*	*3 000*
O&M costs	*-3 000*	*-3 000*	*-3 000*

Table 21: EV charging scenarios (BM 1, Sensitivity to EV penetration)

By modifying the number of EV customers in Table 21 (orange cells), the sensitivity of the different prices to such parameter can be assessed. As in the base case, the prices for clearing, marketplace access, charging service and EV charging were obtained for each actor to have an annual net income of 10% of its annual expenditures.

Figure 14 presents the effect of varying the number of EV customers on the charging service price (requested by the EVSE Operator) and on the EV charging price (the price paid by EV customers to the EVSP) in the three scenarios.

Under any EV penetration level, the prices in the long-term scenario are 0.15 €/charging lower than the ones in the short-term scenario, resulting from the lower EVSE installation cost. Therefore, the prices in the medium-term scenario are about an average of the prices in the short-term scenario and in the long-term scenario.

As expected, the more the EV customers in the system are, the lower the prices to be charged will be. For less than 5 000 EV customers, the EV charging price remains above 2 €/charging in three scenarios and it reaches an almost stable price once 200 000 customers are reached (about 1.40 €/charging in the short-term scenario and about 1.25 €/charging in the long-term scenario).

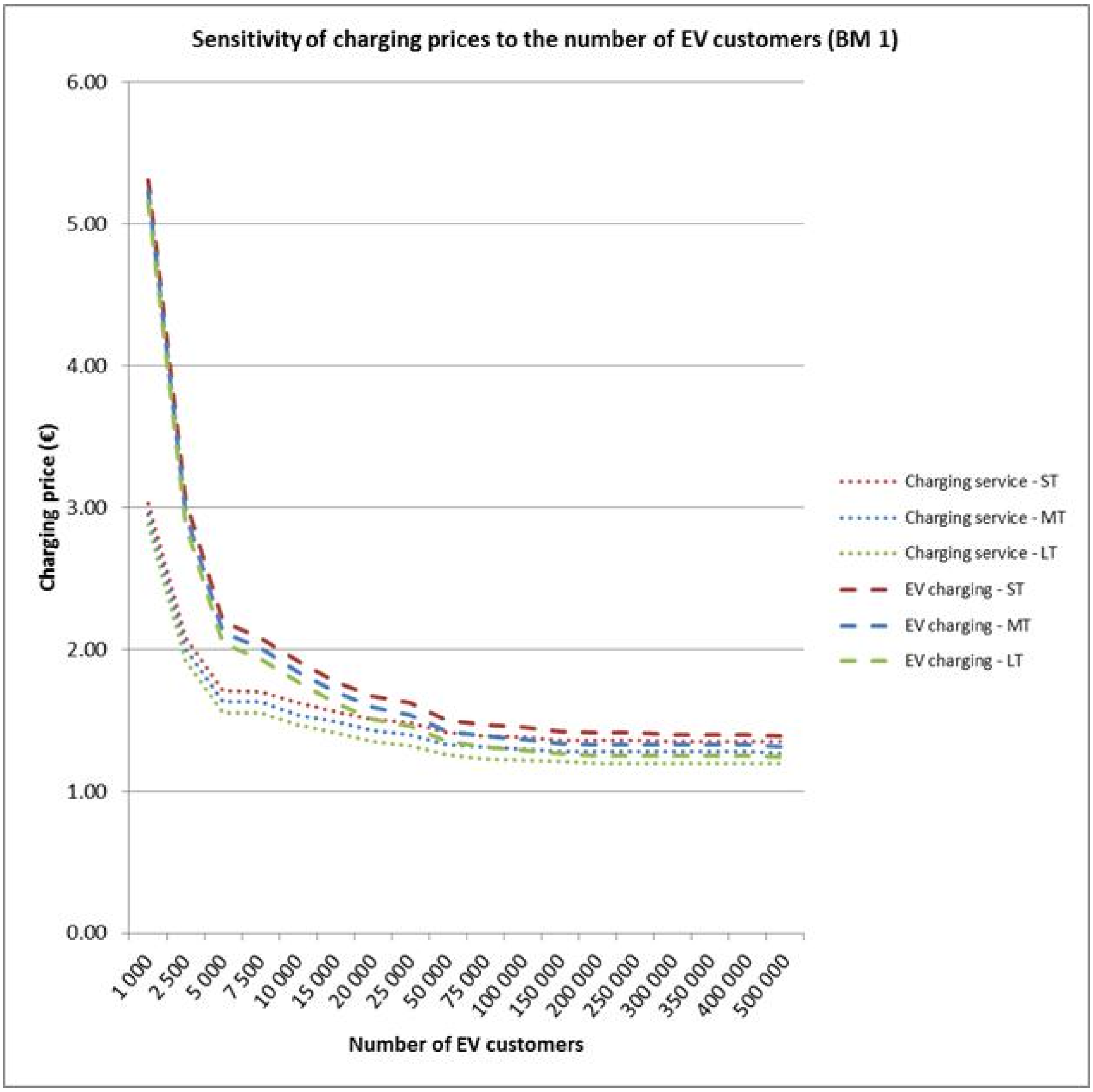

Figure 14: Sensitivity of charging service and EV charging prices to EV penetration (BM 1)

Due to its strong linkage to the EV charging price, mileage cost is also reduced as the number of EV customers increases (see **Figure 15**), with a more noticeable effect in low-penetration conditions.

It is important to highlight that the EV add-on costs are kept constant for the same year, regardless of the number of EV customers considered. Therefore, the add-on costs in the short-term scenario are 2 000 € (see Table 21), both for 1 000 EV customers and for 500 000.

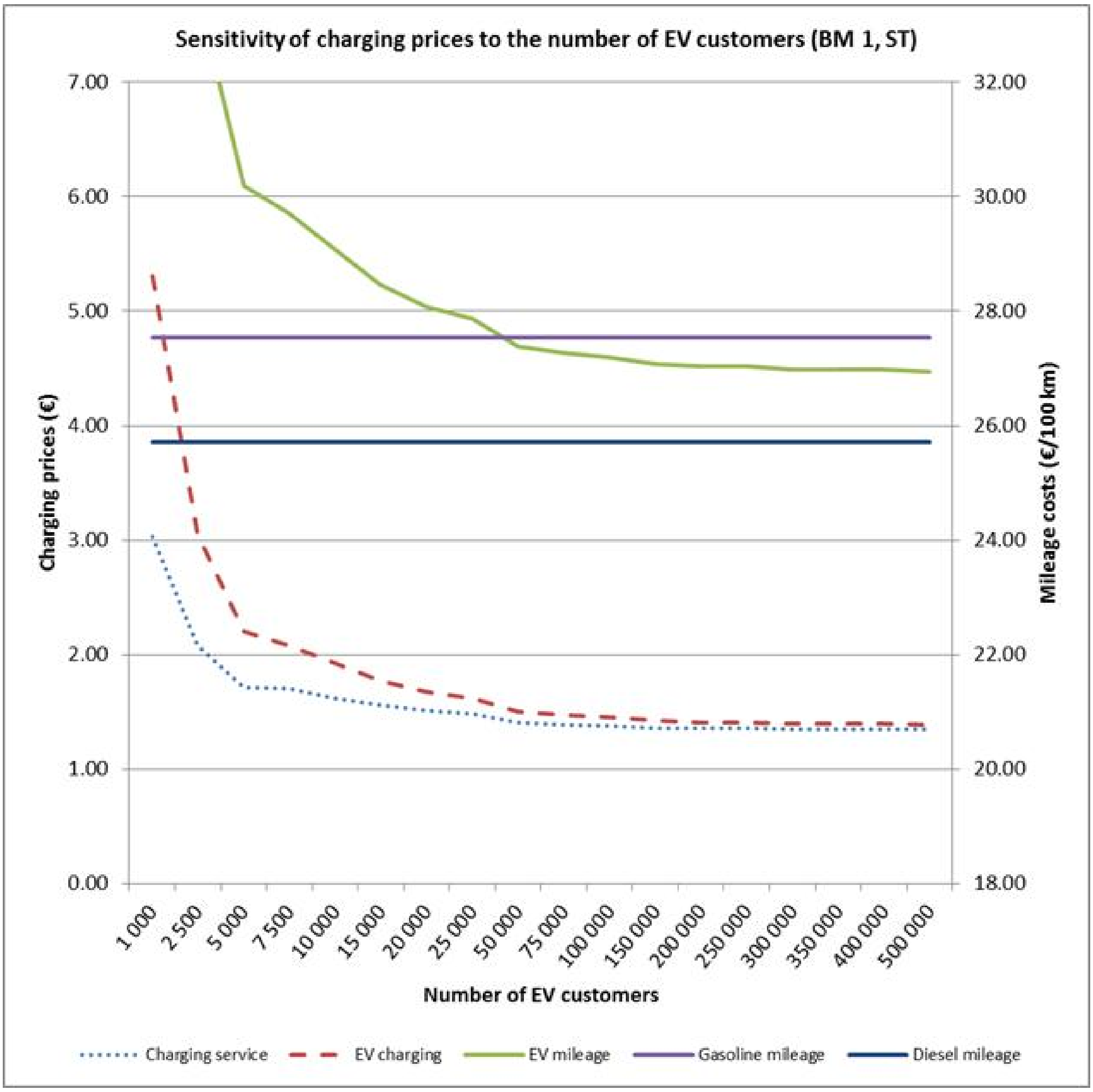

Figure 15: Sensitivity of charging prices and mileage cost to EV penetration (BM 1, ST)

Due to the high EV purchase costs in the short-term scenario, EV mileage cost is always higher than the one of diesel vehicles. On the contrary, EV's mileage cost is lower than the one for the gasoline vehicle when there are more than about 35 000 EV customers.

In the medium-term scenario (see **Figure 16**), due to the reductions in both EV charging service and the EV purchase cost, EV mileage cost is lower than the gasoline mileage cost when there are more than 7 500 EV customers, and it is also lower than the mileage cost for diesel vehicles when there are more than 20 000 EV customers.

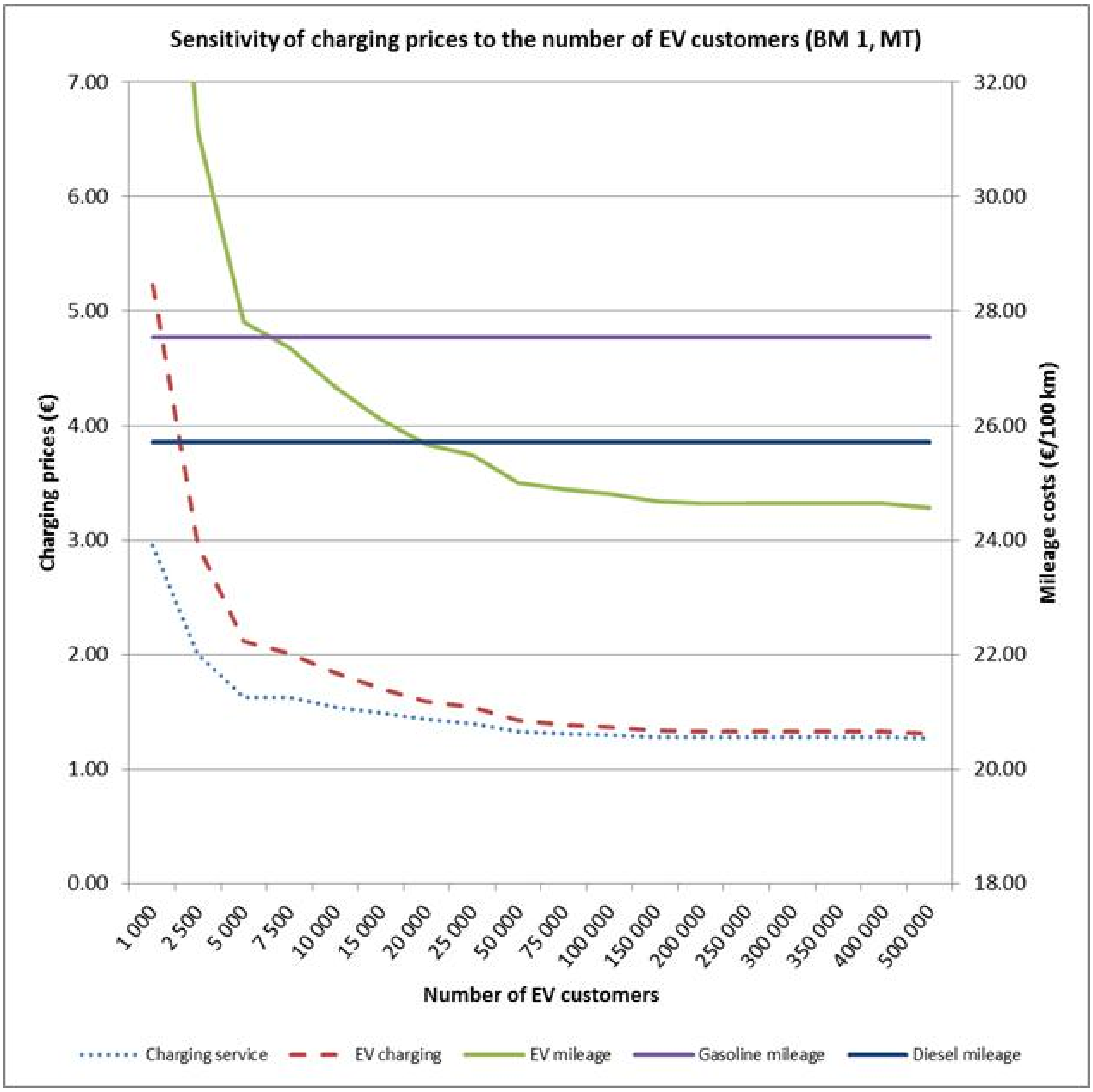

Figure 16: Sensitivity of charging prices and mileage cost to EV penetration (BM 1, MT)

In the long-term scenario, the thresholds for EVs to have lower mileage costs than ICEV are further reduced, to about 3 500 and 10 000 EV customers respectively, as **Figure 17** shows.

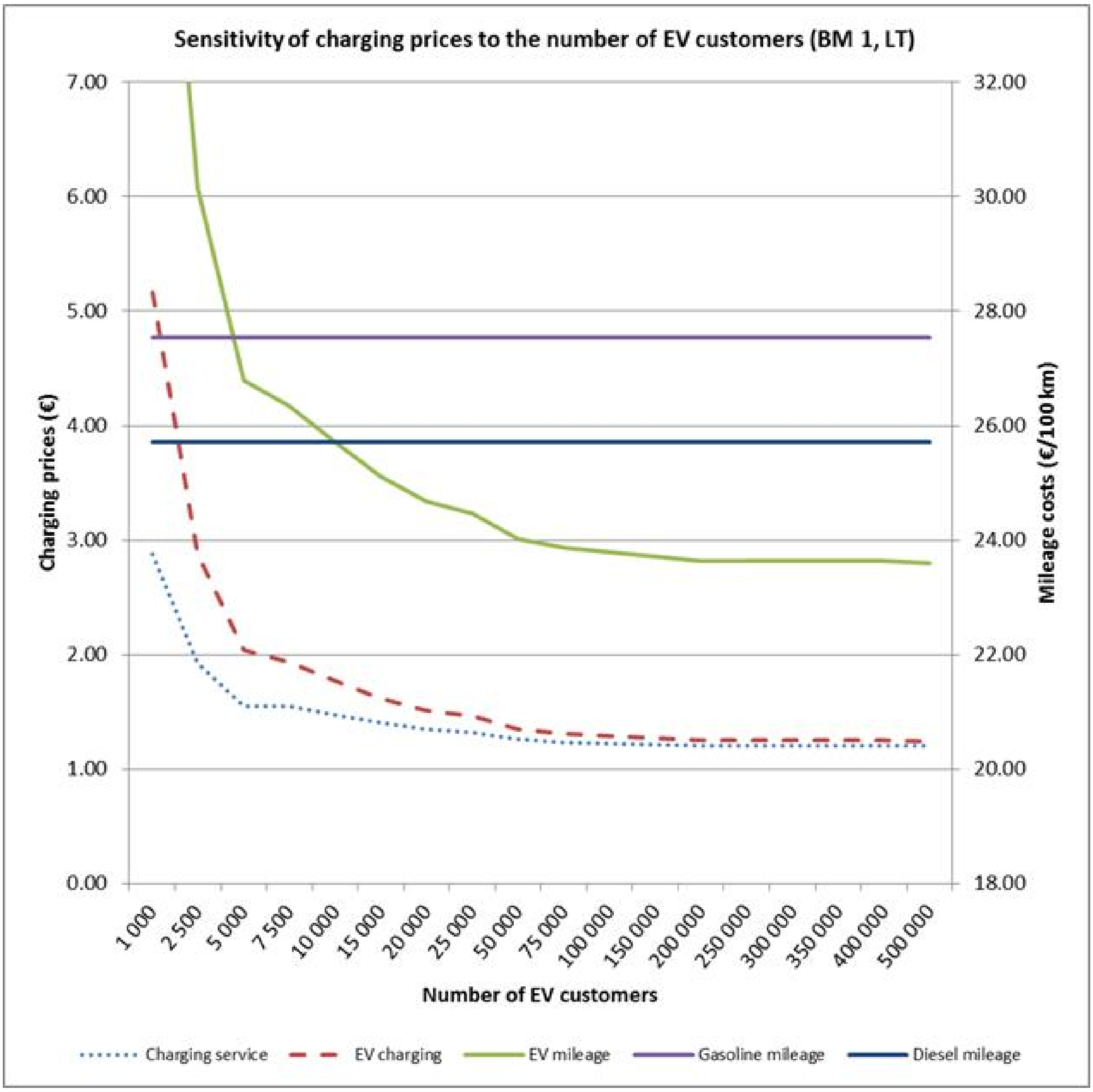

Figure 17: Sensitivity of charging prices and mileage cost to EV penetration (BM 1, LT)

Although the effect of competition is not analysed in detail, a rough estimation of the maximum number of EVSE Operators and EVSPs that can make a profitable business is presented here.

By assuming that there are as many EVSE Operators as EVSPs (as it is done in this analysis) and taking into account the rest of the assumptions of the analysis (which, as stated above, is not very likely to happen throughout the EU), the maximum number of EVSE Operators and EVSPs that can make a profitable business in each scenario is presented in Table 22.

	ST	MT	LT
Number of potential EV customers in EU [EGVI 2012]	500 000	2 000 000	5 000 000
Minimum number of EV customers to be competitive with			
gasoline	35 000	7 500	3 500
diesel	-	20 000	10 000
Maximum number of EVSE Operators/EVSP in EU			
gasoline	14	266	1 428
diesel	0	100	500

Table 22: Maximum number of EVSE Operators/EVSPs in EU in the three scenarios (BM 1)

4.2.2 EVSE cost

Another part of the costs included in the EV charging price to be satisfied by EV customers is related to the EVSE installation costs. The sensitivity analysis considered the values in Table 23 and in Table 24.

Item	Value
Communication price (€/communication event)	0.01
Number of charges per customer per day	1
Type of Time of Use (ToU) tariff for electricity	Flat
Type of Time of Use (ToU) tariff for EV charging	Flat
EVSE ratio per EV customer (EVSE/customer)	0.2
Energy charged per charging event (kWh)	3
EVSE O&M costs (€/year)	500
EVSE lifetime (years)	10
RFID card cost (€)	20
RFID card lifetime (years)	20
EVSE, RFID card, EV purchase discount rate	7%
Average EV lifetime (years)	10
EV consumption (Wh/km)	120

Table 23: EV charging conditions (BM 1, Sensitivity to EVSE cost)

	ST	MT	LT
Number of EV customers	5 000	50 000	250 000
Number of EVSE	1 000	10 000	50 000
EVSE installation cost (€)	6 500	5 600	4 700
Civil work	*2 000*	*2 000*	*2 000*
Grid connection	*1 500*	*1 500*	*1 500*
Hardware	*3 000*	*2 100*	*1 200*
Add-on cost of an EV compared to an ICEV (€)	2 000	500	0
Purchase cost	*5 000*	*3 500*	*3 000*
O&M costs	*-3 000*	*-3 000*	*-3 000*

Table 24: EV charging scenarios (BM 1, Sensitivity to EVSE cost)

By modifying the EVSE hardware cost in Table 24 (orange cells), the total EVSE cost is modified (it is assumed that the costs of the civil work and grid connection will remain constant in the three scenarios).

Again, the prices for clearing, marketplace access, charging service and EV charging were obtained for each actor to have an annual net income of 10% of its annual expenditures.

Figure 18 presents the effect of varying the EVSE hardware cost on the charging service price (requested by the EVSE Operator) and on the EV charging price (the price paid by EV customers to the EVSP) in the three scenarios.

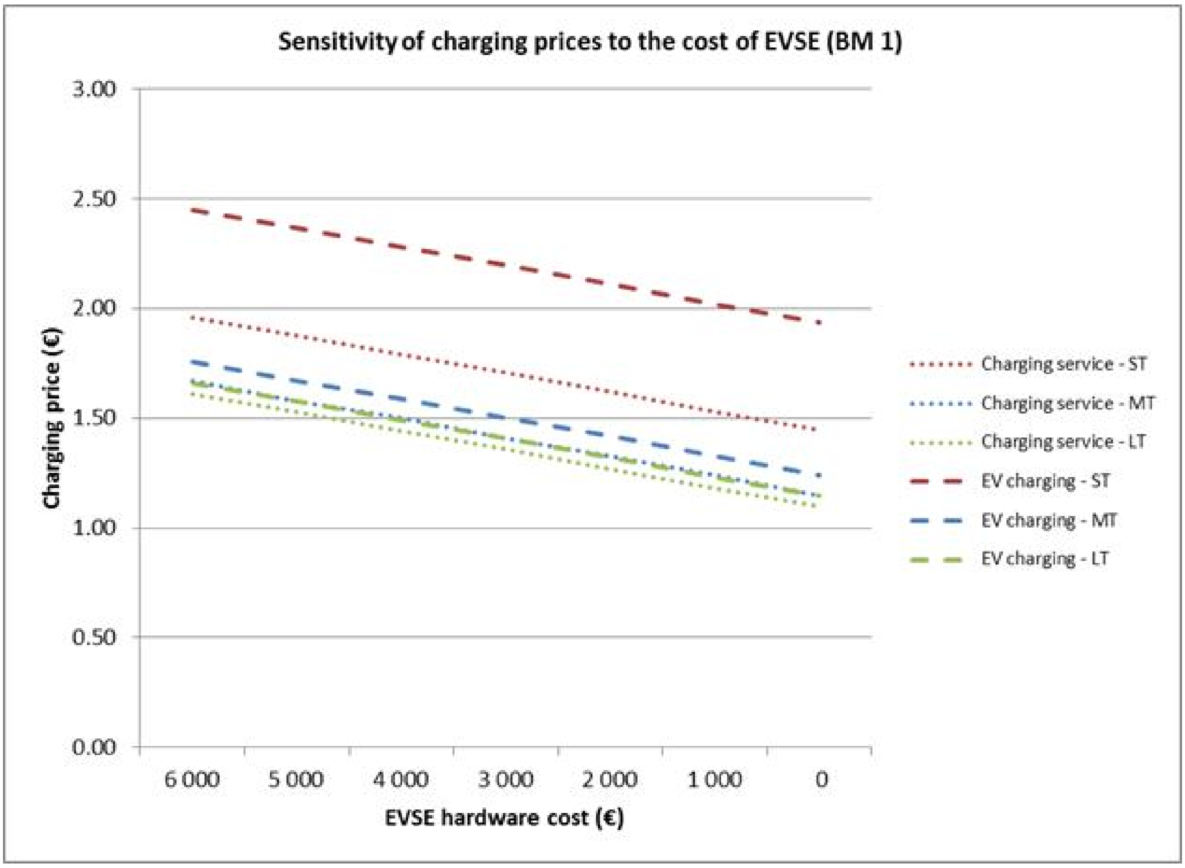

Figure 18: Sensitivity of charging service and EV charging prices to EVSE cost (BM 1)

Under any EVSE hardware cost, the prices in the long-term scenario are 0.79 €/charging lower than the ones in the short-term scenario, resulting from the higher number of EV customers, while the prices in the medium-term scenario are about 0.10 €/charging cheaper than in the short-term scenario.

As expected, the lower the costs of EVSE hardware (and, hence, EVSE) are, the lower the prices to be charged will be. The dependence between both parameters is represented as a linear function, where EV charging price is reduced by 0.085 €/charging when EVSE hardware cost is reduced in 1 000 €.

Due to its strong linkage to the EV charging price, mileage cost is also reduced as the cost of EVSE hardware is reduced (see **Figure 19**).

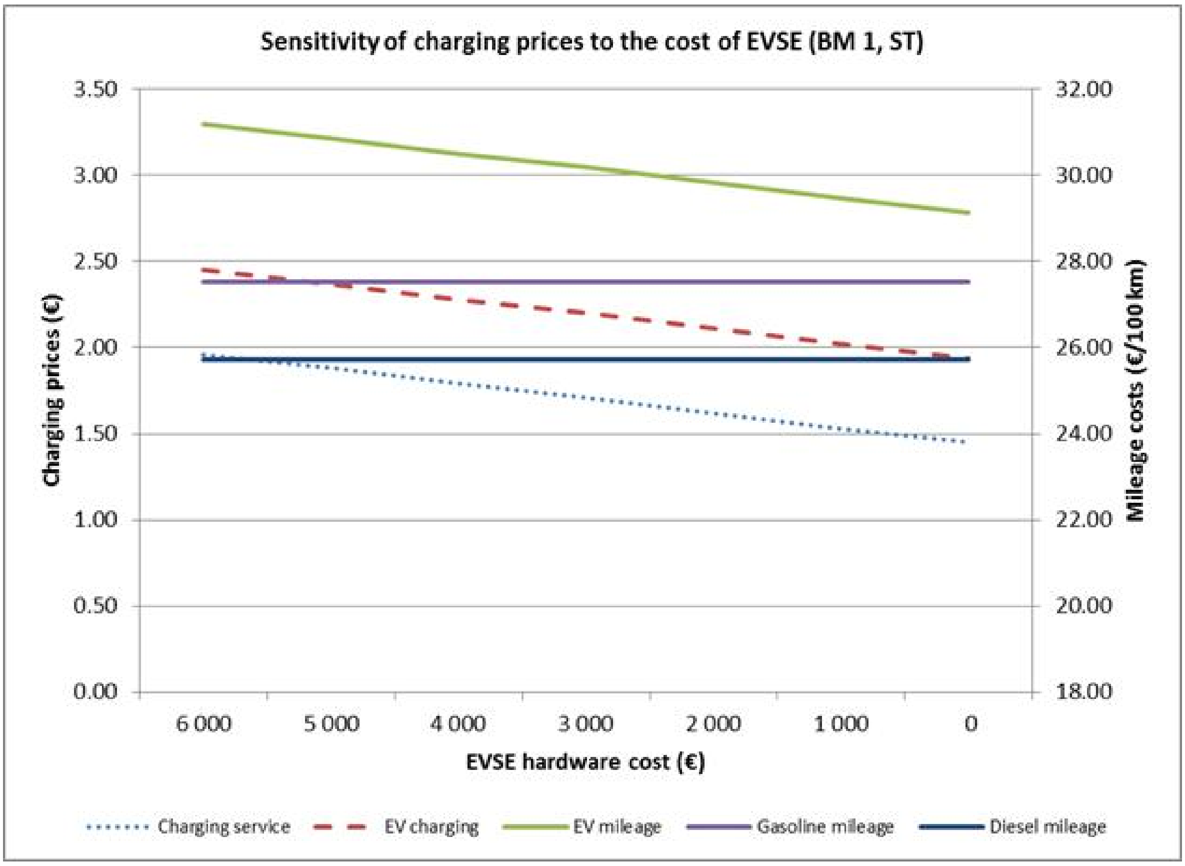

Figure 19: Sensitivity of charging prices and mileage cost to EVSE cost (BM 1, ST)

Due to the high EV purchase costs and the relatively low EV penetration in the short-term scenario, EV mileage cost is always higher than the ones for ICEV.

However, the strong reduction in EV purchase costs, together with the deeper EV penetration, makes the EV mileage cost competitive with ICEV mileage costs in the medium-term scenario, as **Figure 20** shows. EV mileage cost is lower than gasoline mileage cost for all the EVSE hardware cost considered[15] and it falls below diesel mileage cost when EVSE hardware is cheaper than 4 000 €.

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[15] In [NPE 2011], the highest costs for existing EVSE are assumed to be 10 000 €, which would mean 6500 € for hardware costs.

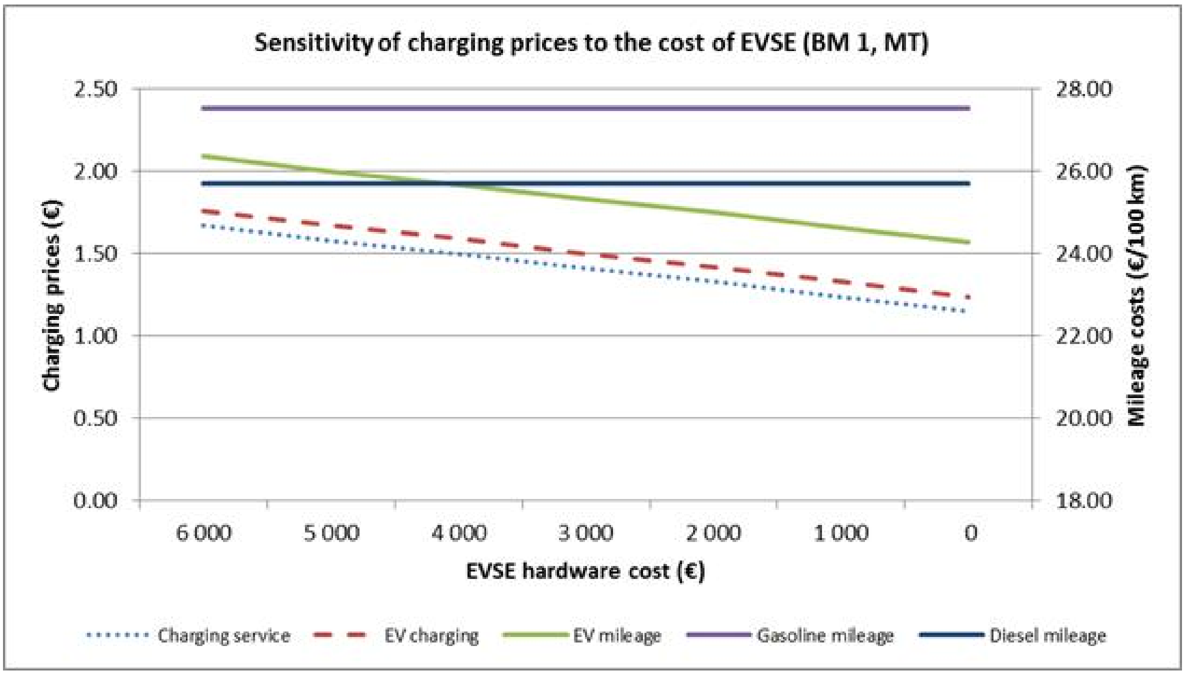


Figure 20: Sensitivity of charging prices and mileage cost to EVSE cost (BM 1, MT)

As EV purchase costs are further reduced and EV penetration is more widespread in the long-term scenario, EV mileage costs are even lower and fall below ICEV costs for all the EVSE hardware cost considered (see **Figure 21**).

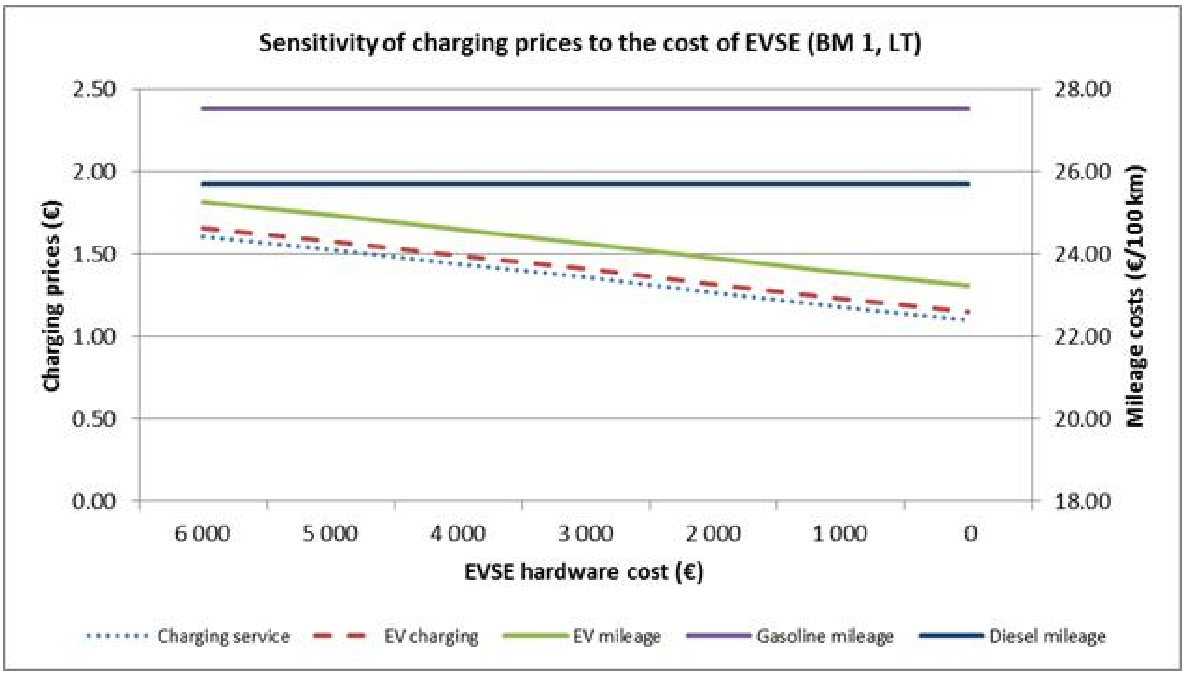


Figure 21: Sensitivity of charging prices and mileage cost to EVSE cost (BM 1, LT)

4.2.3 Energy charged

The EV charging price also includes the costs of energy procurement. As the amount of energy to be charged decreases, the EV charging price will also decrease but, at the same time, it will also have a lower contribution to the recovery of company running costs.

In the base case, the average mileage of a European vehicle user has been considered. According to [EC 2013, 3], it was 9 500 km/year in 2010. Based on [EGVI 2012], EV consumption has been set to 120 Wh/km, which means that an average EV customer would charge 1 140 kWh per year, or 3.12 kWh per day.

This figure is in line with the findings in Green eMotion WP1. As stated in [Brady 2013], average EV consumption in the demo regions was 5.13 kWh, and EVs charge every 33.8 hours on average, which gives an annual consumption of 1 330 kWh, or 3.64 kWh/day.

However, the standard deviation of the amount of energy charged is 4.66 kWh, and the time between charges also has a standard deviation of 35.2 hours, which gives an idea of the dispersion of results.

In order to check the effect of such variability on the economic performance of the BM, a sensitivity analysis has been performed on this parameter, by considering the conditions in Table 25 (except the orange cells, which are used for the sensitivity analysis) and in Table 26.

Item	Value
Communication price (€/communication event)	0.01
Number of charges per customer per day	1
Type of Time of Use (ToU) tariff for electricity	Flat
Type of Time of Use (ToU) tariff for EV charging	Flat
EVSE ratio per EV customer (EVSE/customer)	0.2
Energy charged per charging event (kWh)	3
EVSE O&M costs (€/year)	500
EVSE lifetime (years)	10
RFID card cost (€)	20
RFID card lifetime (years)	20
EVSE, RFID card, EV purchase discount rate	7%
Average EV lifetime (years)	10
EV consumption (Wh/km)	120

Table 25: EV charging conditions (BM 1, Sensitivity to the energy charged)

	ST	MT	LT
Number of EV customers	5 000	50 000	250 000
Number of EVSE	1 000	10 000	50 000
EVSE installation cost (€)	6 500	5 600	4 700
Civil work	*2 000*	*2 000*	*2 000*
Grid connection	*1 500*	*1 500*	*1 500*
Hardware	*3 000*	*2 100*	*1 200*
Add-on cost of an EV compared to an ICEV (€)	2 000	500	0
Purchase cost	*5 000*	*3 500*	*3 000*
O&M costs	*-3 000*	*-3 000*	*-3 000*

Table 26: EV charging scenarios (BM 1, Sensitivity to the energy charged)

As in the rest of the cases, the prices for clearing, marketplace access, charging service and EV charging were obtained so that each actor has an annual net income of 10% of its annual expenditures (staff, overheads, O&M and annuitized investment).

The effect of increasing energy demand on the charging service price (requested by the EVSE Operator) and on the EV charging price (the price paid by EV customers to the EVSP) in the three scenarios is presented in **Figure 22**.

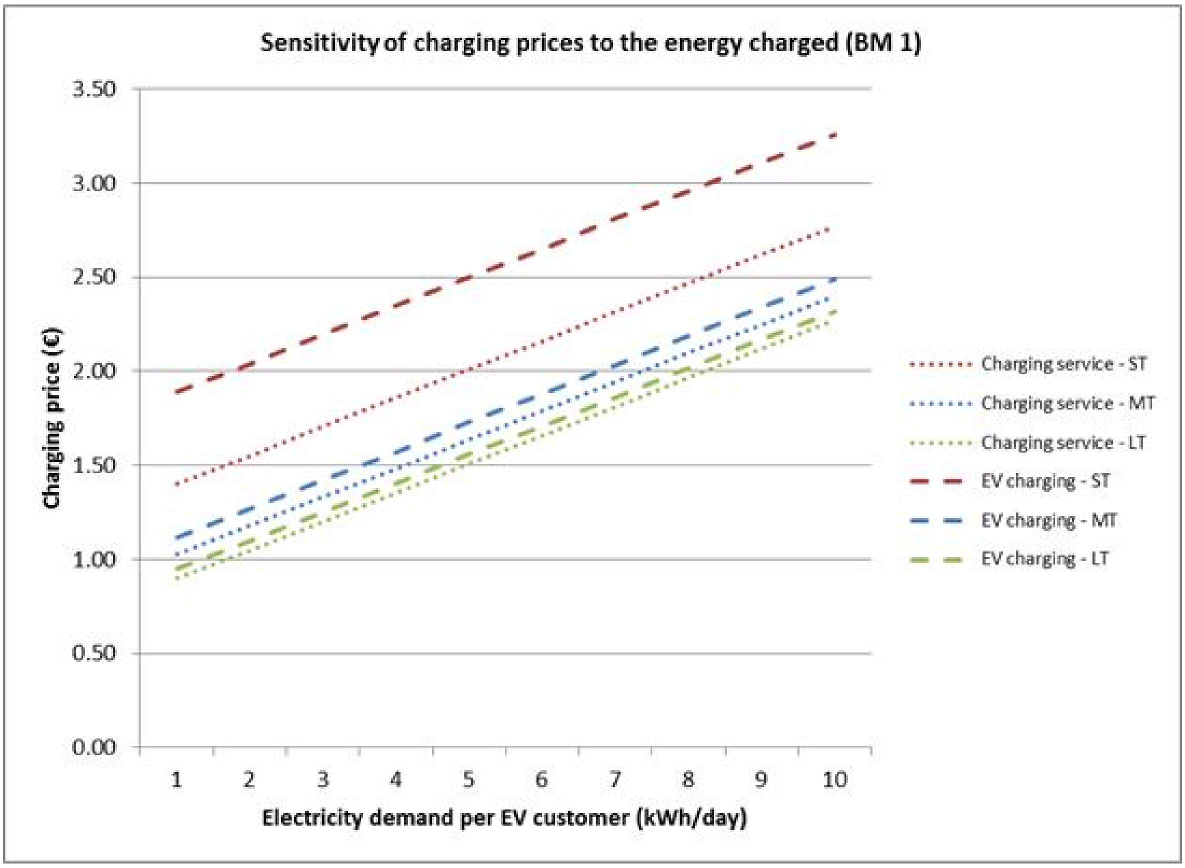


Figure 22: Sensitivity of charging service and EV charging prices to the energy charged (BM 1)

Under any daily demand by EV customers, the prices in the long-term scenario are about 0.95 €/charging lower than the ones in the short-term scenario, resulting from the higher number of EV customers and lower EVSE cost, while the prices in the medium-term scenario are about 0.78 €/charging cheaper than in the short-term scenario.

In this case, as more energy is consumed, charging prices increase. The dependence between both parameters is represented as a linear function, where EV charging price is increased by 0.15 €/charging when an additional kWh is charged.

On the contrary to the cases presented so far, as EV charging price increases, mileage cost is reduced. The reason is that EV charging price increases results from a higher usage rate (EV customers charge more kWh to drive longer distances) and a higher usage rate reduces the share of fixed costs (especially EV purchase cost, but also staff & overheads, equipment amortisation…) in the mileage cost (see **Figure 23**).

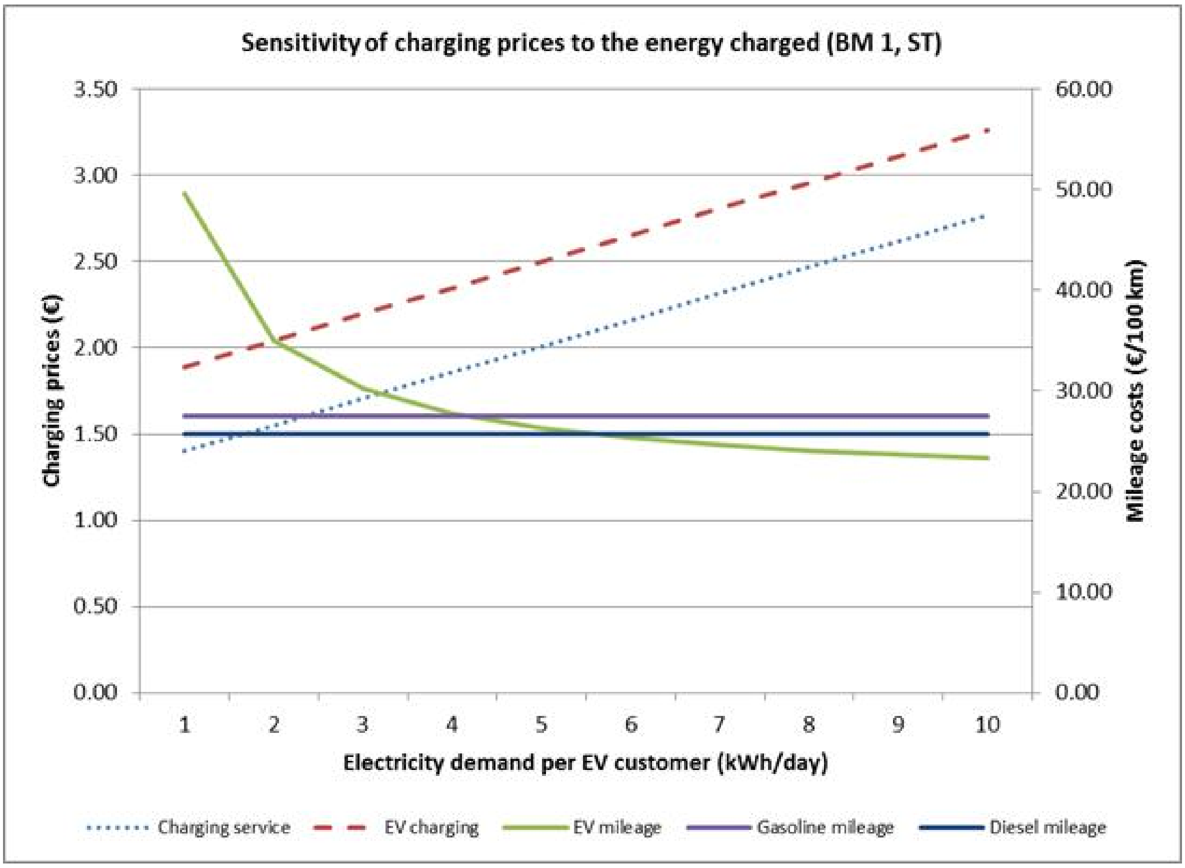


Figure 23: Sensitivity of charging prices and mileage cost to the energy charged (BM 1, ST)

As EV usage increases, its mileage cost can become comparable to the ones by ICEV at about 4-5 kWh/day (12000-15000 km/year[16]). With the assumed number of public EVSE per EV customer, by assuming that charging is made at 3.68 kW (230V, 16A, cos φ = 1, section 4.1) and taking the highest mileage (15 000 km/year), the number of hours in which public EVSE are used can be calculated as:

$$\text{EVSE usage time} = \frac{5\ \text{kWh/EV.day}}{0.2\frac{\text{EVSE}}{\text{EV}}*3.68\ \text{kW}} = 6.79\ \text{hours/day}$$

The strong reduction in EV purchase costs, together with the deeper EV penetration, makes the EV mileage cost competitive with ICEV mileage costs in the medium-term scenario with lower public mileage rates (about half of the annual kilometres in the short-term scenario), as **Figure 24** shows.

[16] This study only refers to public charging, so these mileages refer to mileages made by charging in public EVSE.

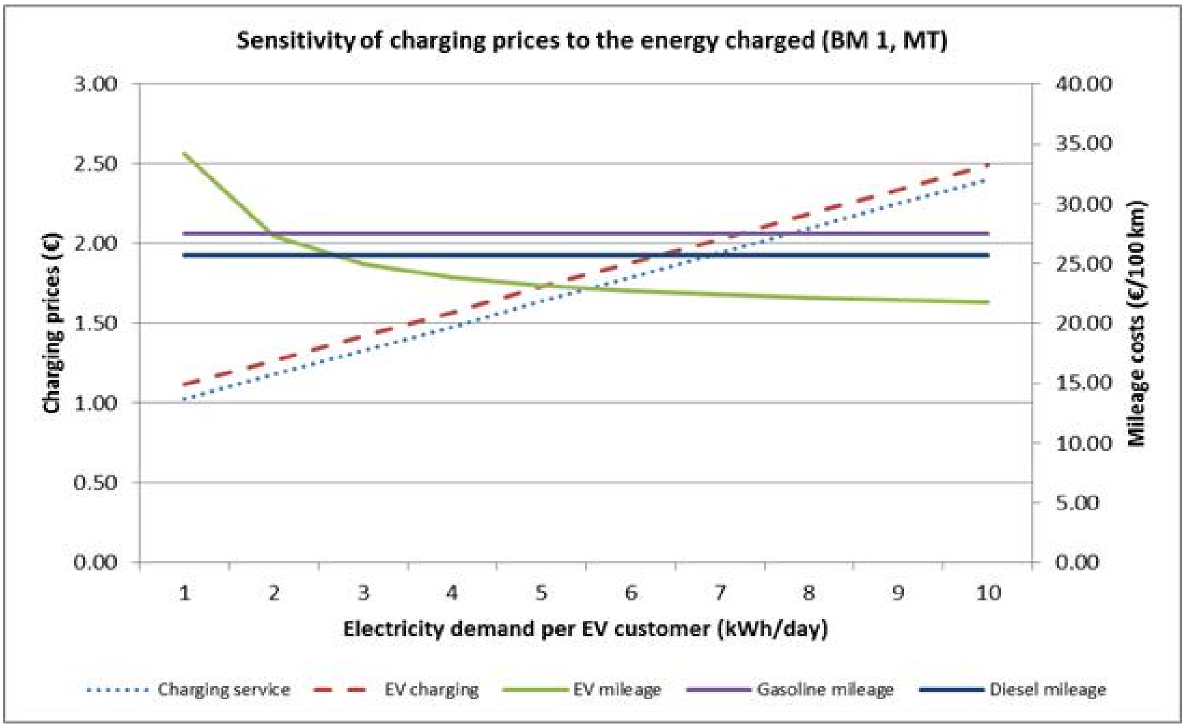


Figure 24: Sensitivity of charging prices and mileage cost to the energy charged (BM 1, MT)

In the long-term scenario, an annual mileage based on public charging of just 6 000 km (2 kWh/day or 2.71 h/day of EVSE usage) is enough to make EV competitive with any type of ICEV (see **Figure 25**).

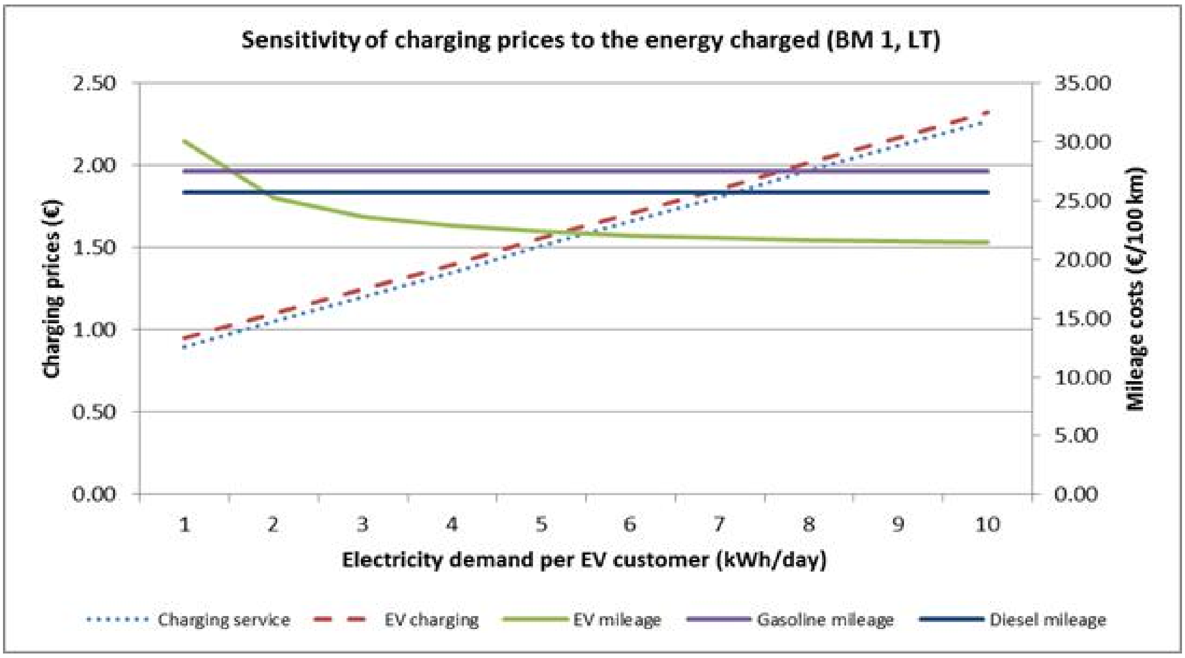


Figure 25: Sensitivity of charging prices and mileage cost to the energy charged (BM 1, LT)

4.2.4 Number of public EVSE per EV customer

Another parameter that influences the EV charging price is the number of EVSE per customer. The higher the number of EVSE per customer is, the higher the required investment to provide the charging service will be and, hence, the EV charging service price. In other words, if there are too many EVSE, they may well likely be under-utilised, with the corresponding business loss for the EVSE Operator. On the contrary, a low rate of publicly available EVSE may slow down the adoption of electric mobility, due to range anxiety concerns for EV customers.

In order to check its impact on this BM, a sensitivity analysis has been performed on this parameter, by considering the conditions presented in Table 27 and in Table 28.

Item	Value
Communication price (€/communication event)	0.01
Number of charges per customer per day	1
Type of Time of Use (ToU) tariff for electricity	Flat
Type of Time of Use (ToU) tariff for EV charging	Flat
EVSE ratio per EV customer (EVSE/customer)	0.2
Energy charged per charging event (kWh)	3
EVSE O&M costs (€/year)	500
EVSE lifetime (years)	10
RFID card cost (€)	20
RFID card lifetime (years)	20
EVSE, RFID card, EV purchase discount rate	7%
Average EV lifetime (years)	10
EV consumption (Wh/km)	120

Table 27: EV charging conditions (BM 1, Sensitivity to the number of public EVSE per EV customer)

	ST	MT	LT
Number of EV customers	5 000	50 000	250 000
EVSE installation cost (€)	6 500	5 600	4 700
Civil work	*2 000*	*2 000*	*2 000*
Grid connection	*1 500*	*1 500*	*1 500*
Hardware	*3 000*	*2 100*	*1 200*
Add-on cost of an EV compared to an ICEV (€)	2 000	500	0
Purchase cost	*5 000*	*3 500*	*3 000*
O&M costs	*-3 000*	*-3 000*	*-3 000*

Table 28: EV charging scenarios (BM 1, Sensitivity to the number of public EVSE per EV customer)

Considering the present evolution of EV market and the number of publicly accessible EVSE[17], it is quite unlikely that the share of publicly accessible EVSE will be lower than the 10% target established in [EC 2013, 1], [EC 2013, 2].

Therefore, the analysis of the impact of the number of public EVSE per EV customer will consider a penetration of 0.2 (reference), 0.4, 0.6, 0.8 and 1.0.

Again, the prices for clearing, marketplace access, charging service and EV charging were obtained as in the other cases, i.e. so that each actor has an annual net income of 10% of its annual expenditures (staff, overheads, O&M and annuitized investment).

The effect of increasing number of publicly accessible EVSE per existing EV on the charging service price (requested by the EVSE Operator) and on the EV charging price (the price paid by EV customers to the EVSP) in the three scenarios is presented in **Figure 26**.

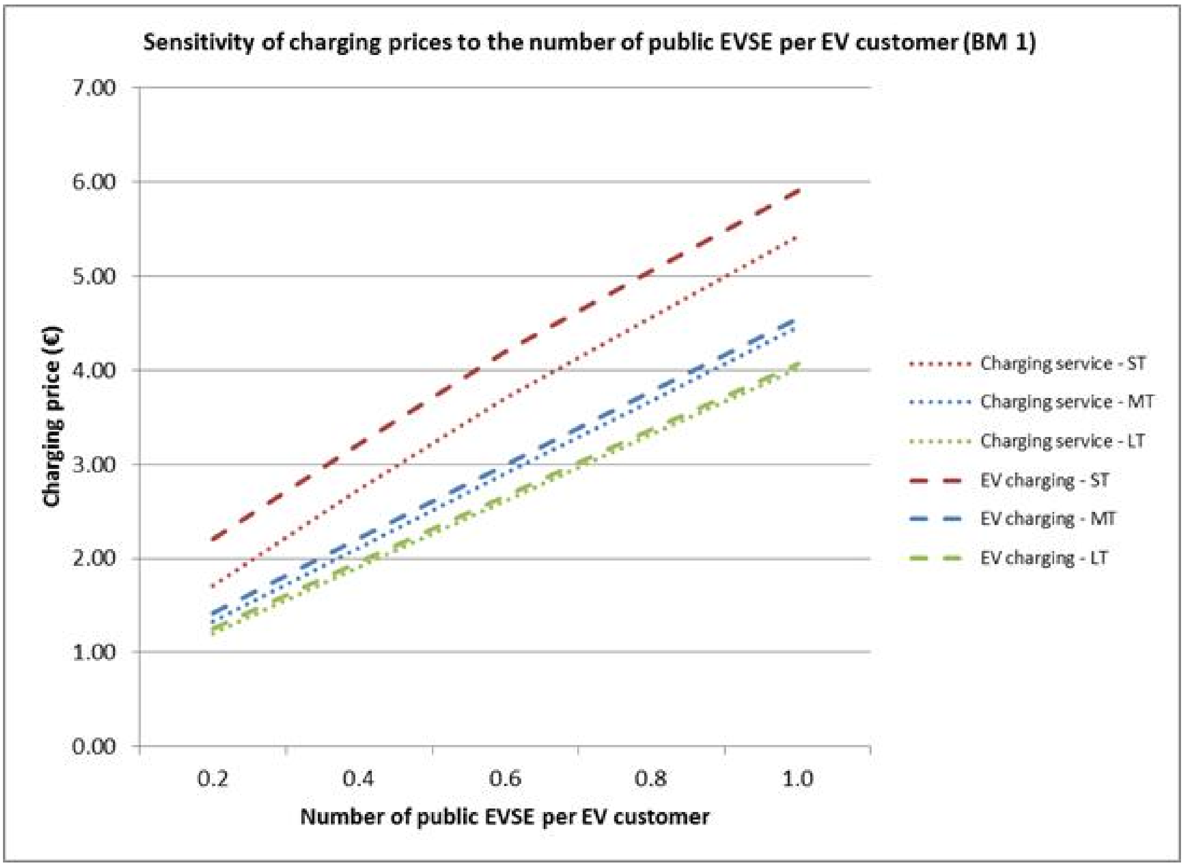


Figure 26: Sensitivity of charging service and EV charging prices to the number of public EVSE per EV customer (BM 1)

[17] The data in [EC 2013, 2] show that there are countries (e.g. France and UK) where there are more EVs than EVSE, so it is assumed that the EVSE figures refer to the publicly available EVSE.

Under any daily demand by EV customers, the prices for the long-term scenario are lower than the ones for the short-term scenario, resulting from the higher number of EV customers and lower EVSE cost, but, on the contrary to the rest of the cases, the difference between scenarios increases as the number of public EVSE per EV customer increases.

An increase in the amount of public EVSE per EV customer results in an increase in the pricing for the charging service and EV charging, as each of them will be used less frequently, but there is no linear relation in this case. Due to its strong linkage to the EV charging price, mileage cost is also increased as there are more public EVSE per EV customer (see **Figure 27**).

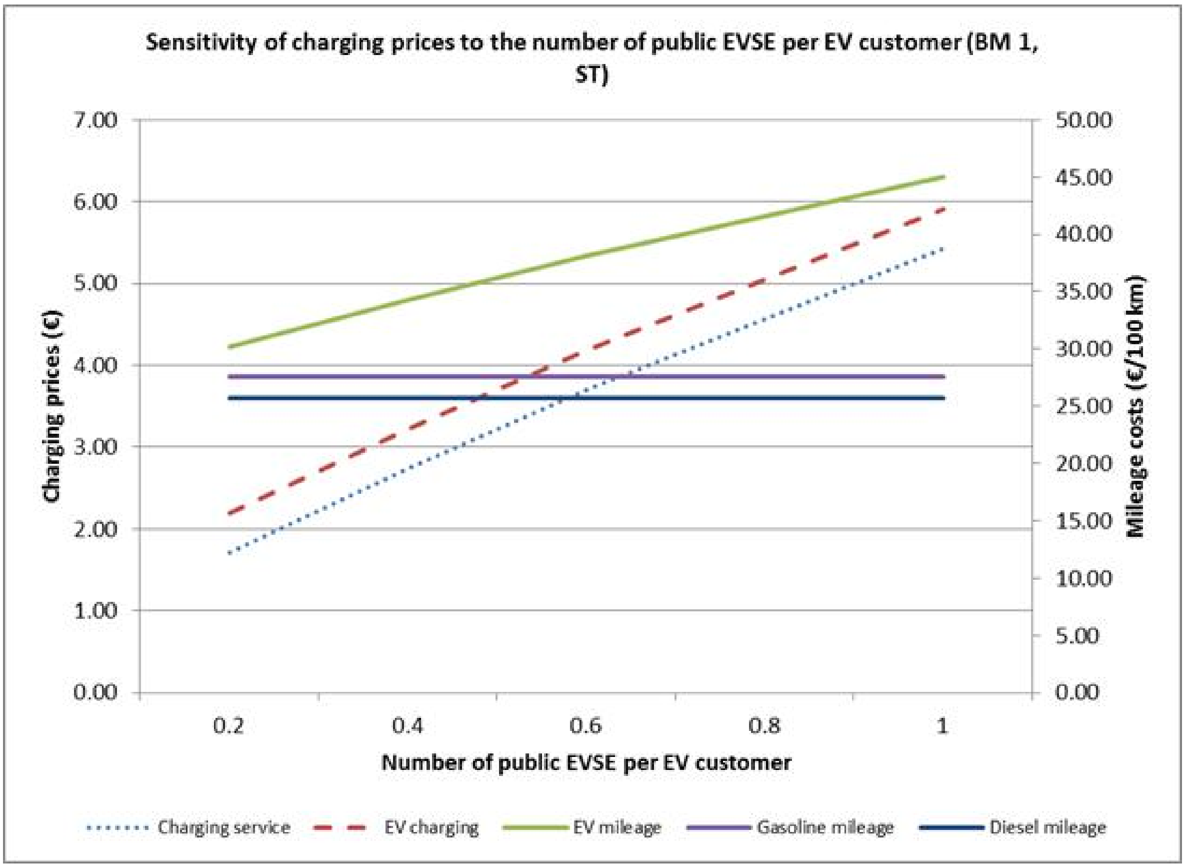


Figure 27: Sensitivity of charging prices and mileage cost to the number of public EVSE per EV customer (BM 1, ST)

In the short-term scenario, EV mileage cost is more expensive than ICEV mileage cost for all the public EVSE deployment strategies considered, being even much more expensive for large-scale public EVSE deployment situations.

The strong reduction in EV purchase costs, together with the deeper EV penetration in the medium-term scenario, makes the EV mileage cost competitive with ICEV mileage costs for public EVSE deployment strategies which install up to 0.2-0.3 public EVSE per customer, as **Figure 28** shows.

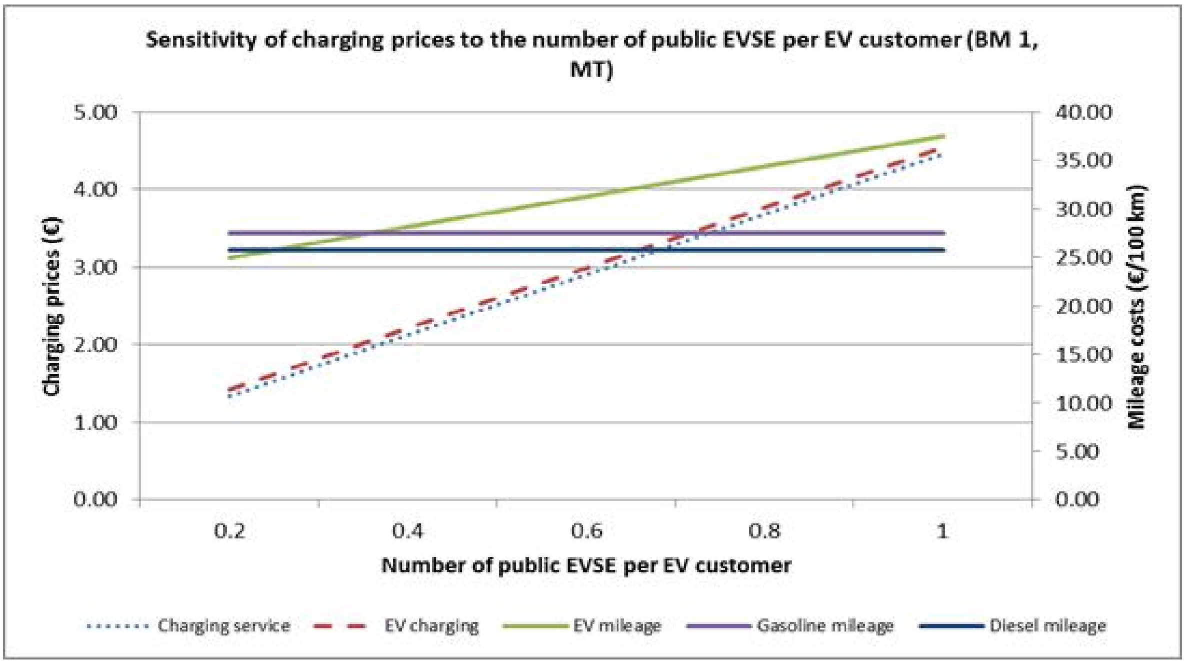


Figure 28: Sensitivity of charging prices and mileage cost to the number of public EVSE per EV customer (BM 1, MT)

In the long-term scenario, the widespread adoption of electric mobility and the comparable purchase cost of EV versus ICEV make it possible to install a higher share of public EVSE per EV customer, but not more than 0.4-0.5 should be installed to have a positive business case (see **Figure 29**).

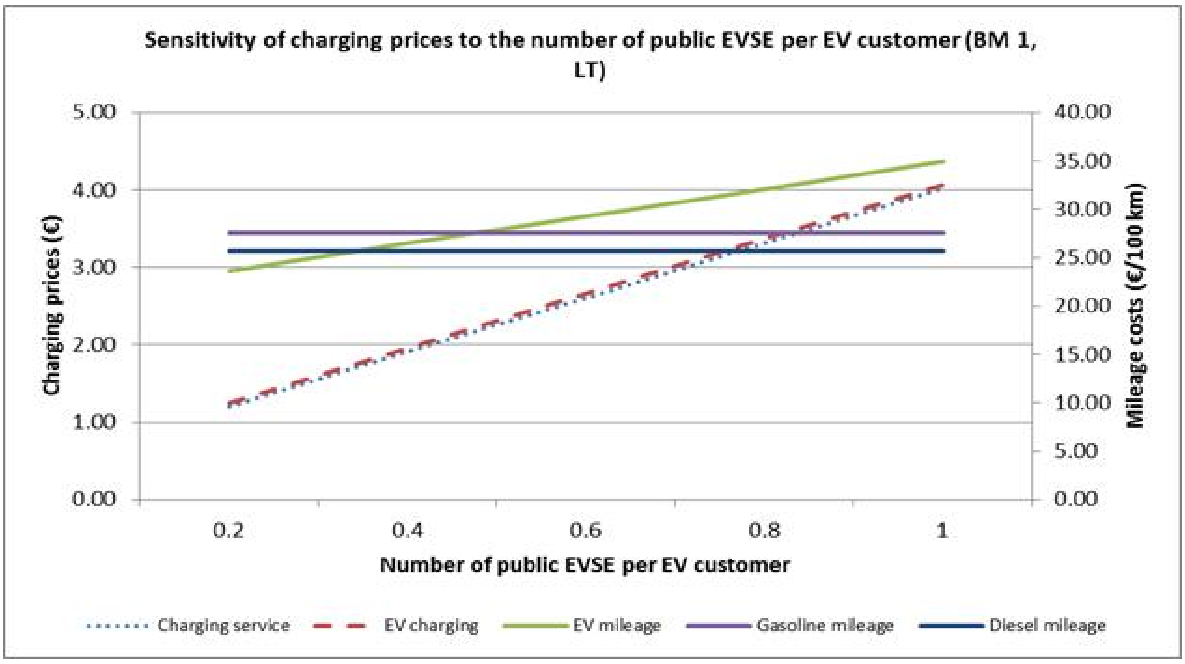


Figure 29: Sensitivity of charging prices and mileage cost to the number of public EVSE per EV customer (BM 1, LT)

4.2.5 Time of Use rates

In the base case, no Time of Use (ToU) tariffs were considered for T&D fees or retail prices, and neither the EVSE Operator nor the EVSP charged a different price for charging the EV in different times of the day. Under this assumption, the distribution of EV charges within a day has no effect on the profitability of the EVSE Operator, the EVSP and the EV customers.

In this subsection, the impact of the distribution of charges between the different periods when different ToU tariffs are used is analysed. For that purpose, three EV charging distribution profiles have been defined. Profile A follows the distribution of the Green eMotion demo regions [McDonald 2013], where most of the charges are made in super-peak period. Profile B represents uniform charging throughout the day (P1 and P2 take 5 hours, while P3 and P4 take 7 hours, so their percentages are not uniform). Profile C represents the case in which the majority of the charges are made in super off-peak period, by exchanging the weights of super-peak and super off-peak periods in Profile A (see Table 29).

Charging distribution profile	A	B	C
% in super-peak period (17:00-22:00)	45%	21%	5%
% in peak period (13:00-17:00, 22:00-23:00)	25%	21%	25%
% in off-peak period (0:00-1:00, 8:00-13:00, 23:00-24:00)	25%	29%	25%
% in super off-peak period (1:00-8:00)	5%	29%	45%

Table 29: EV charging distribution profiles

As described in subsection 3.4.4, the EV charging pricing profiles are based on the ToU tariffs for T&D and retail prices. Table 30 summarises the multipliers for each period in the different ToU tariffs.

Multipliers	Flat tariff	2 period	3 period	4 period
% in super-peak period (17:00-22:00)	1	1.63	1.61	1.92
% in peak period (13:00-17:00, 22:00-23:00)	1	1.63	1.61	1.45
% in off-peak period (0:00-1:00, 8:00-13:00, 23:00-24:00)	1	0.55	0.65	0.59
% in super off-peak period (1:00-8:00)	1	0.55	0.48	0.43

Table 30: EV charging pricing multipliers

The rest of the parameters considered are presented in Table 31.

Item	Value
Communication price (€/communication event)	0.01
Number of charges per customer per day	1
EVSE ratio per EV customer (EVSE/customer)	0.2
Energy charged per charging event (kWh)	3
EVSE O&M costs (€/year)	500
EVSE lifetime (years)	10
RFID card cost (€)	20
RFID card lifetime (years)	20
EVSE, RFID card, EV purchase discount rate	7%
Average EV lifetime (years)	10
EV consumption (Wh/km)	120

Table 31: EV charging conditions (BM 1, Sensitivity to ToU tariffs)

There are some other important parameters in which an evolution is assumed for the next years, as presented in Table 32:

	ST	MT	LT
Number of EV customers	5 000	50 000	250 000
Number of EVSE	1 000	10 000	50 000
EVSE installation cost (€)	6 500	5 600	4 700
Civil work	*2 000*	*2 000*	*2 000*
Grid connection	*1 500*	*1 500*	*1 500*
Hardware	*3 000*	*2 100*	*1 200*
Add-on cost of an EV compared to an ICEV (€)	2 000	500	0
Purchase cost	*5 000*	*3 500*	*3 000*
O&M costs	*-3 000*	*-3 000*	*-3 000*

Table 32: EV charging scenarios (BM 1, Sensitivity to ToU tariffs)

As in the rest of the cases, the prices for clearing, marketplace access, charging service and EV charging were obtained so that each actor has an annual net income of 10% of its annual expenditures (staff, overheads, O&M and annuitized investment). However, this case is slightly different, as the EVSP and the EVSE Operator will need to define their pricing strategies based on their expectations about charging distributions.

The effect of having ToU pricing, together with different charge distribution profiles on the EV charging price (the price paid by EV customers to the EVSP) for the different periods is presented in **Figure 30** for the short-term scenario.

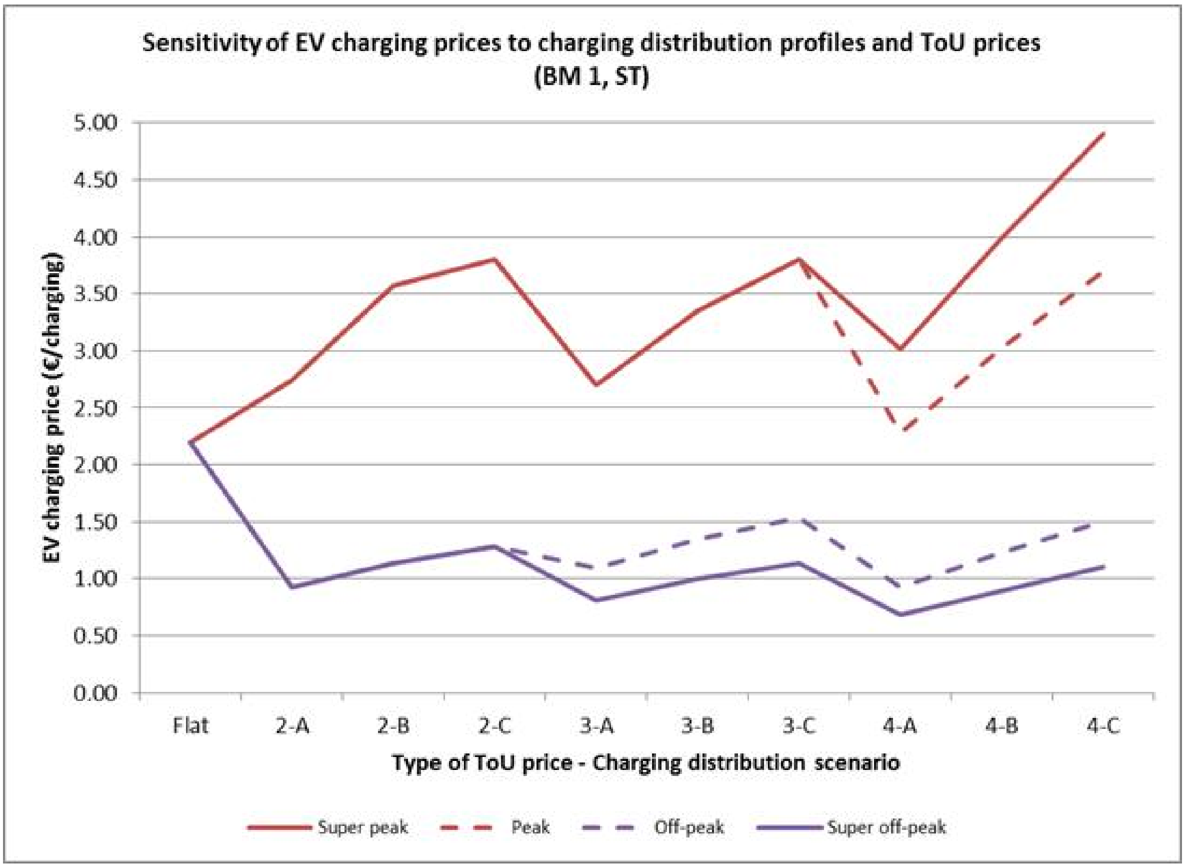


Figure 30: Sensitivity of EV charging price to the charging distribution profile and ToU prices (BM 1, ST)

Within the same number of ToU periods, having more charges at super off-peak periods (profile C) results in overall higher prices, as fixed costs need to be recovered anyway.

The effect on the other two scenarios is similar, although prices are lower (due to the reduction in EVSE costs and the increase in EV customers), as **Figure 31** and **Figure 32** show.

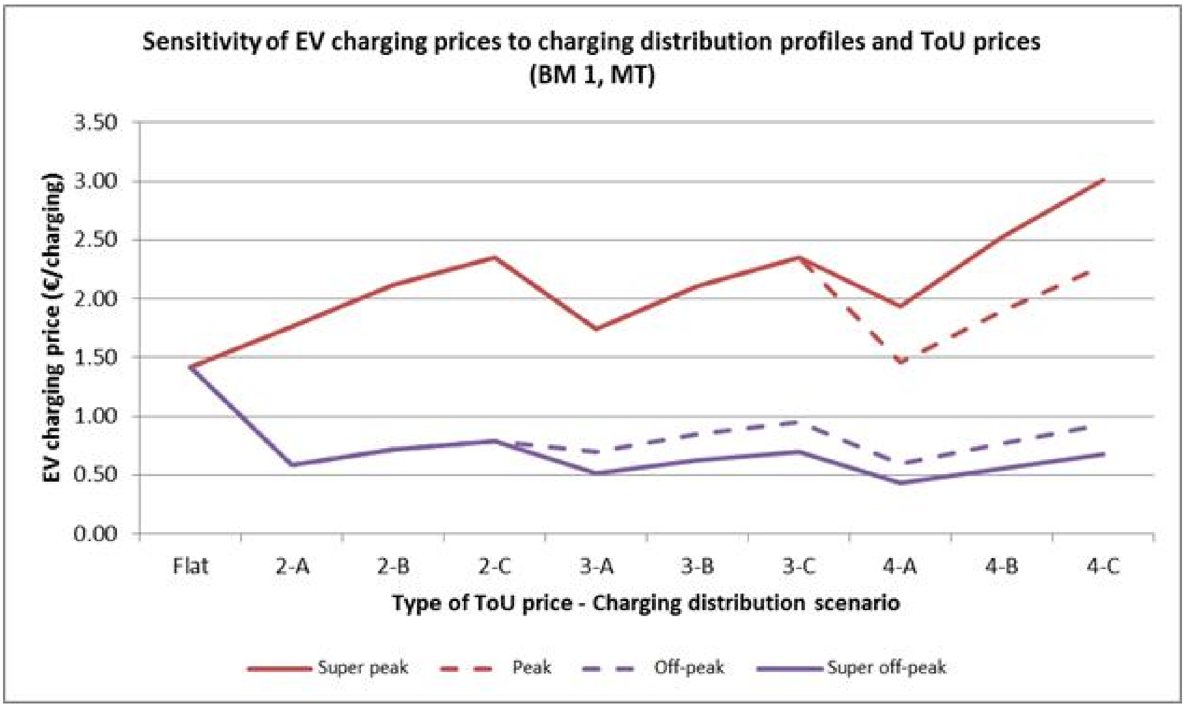


Figure 31: Sensitivity of EV charging price to the charging distribution profile and ToU prices (BM 1, MT)

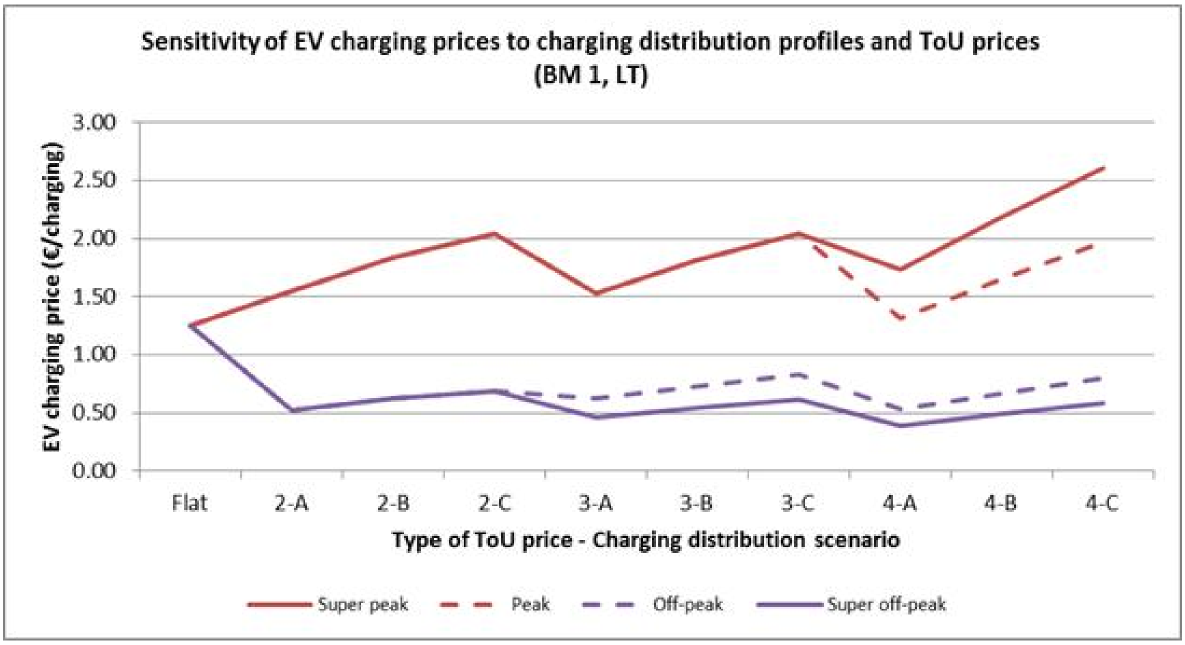


Figure 32: Sensitivity of EV charging price to the charging distribution profile and ToU prices (BM 1, LT)

Table 33 presents the prices for the charging service and for EV charging in the three scenarios, for the different ToU alternatives and charge distribution profiles.

	Charging service (EVSE Operator ← EVSP)			EV charging (EVSP ← EV customer)		
	ST	MT	LT	ST	MT	LT
Flat	1.71	1.33	1.20	2.20	1.42	1.25
2-A peak	2.12	1.65	1.48	2.74	1.76	1.55
2-A off peak	0.72	0.56	0.50	0.92	0.59	0.52
2-B peak	2.58	1.97	1.76	3.57	2.12	1.84
2-B off peak	0.87	0.67	0.59	1.14	0.72	0.62
2-C peak	2.89	2.18	1.94	3.80	2.35	2.04
2-C off peak	0.97	0.74	0.65	1.28	0.79	0.69
3-A peak	2.09	1.63	1.47	2.70	1.74	1.53
3-A off peak	0.85	0.66	0.59	1.09	0.70	0.62
3-A super off peak	0.62	0.48	0.44	0.81	0.52	0.46
3-B peak	2.56	1.96	1.74	3.35	2.11	1.82
3-B off peak	1.03	0.79	0.70	1.35	0.85	0.73
3-B super off peak	0.76	0.59	0.52	1.00	0.63	0.54
3-C peak	2.88	2.19	1.95	3.80	2.35	2.04
3-C off peak	1.16	0.88	0.79	1.53	0.95	0.83
3-C super off peak	0.86	0.65	0.58	1.13	0.70	0.61
4-A super peak	2.34	1.82	1.65	3.01	1.94	1.73
4-A peak	1.77	1.38	1.25	2.28	1.46	1.31
4-A off peak	0.72	0.56	0.51	0.93	0.60	0.53
4-A super off peak	0.52	0.41	0.37	0.68	0.43	0.39
4-B super peak	3.05	2.34	2.09	3.99	2.52	2.19
4-B peak	2.31	1.77	1.58	3.02	1.90	1.65
4-B off peak	0.94	0.72	0.64	1.23	0.77	0.67
4-B super off peak	0.68	0.52	0.47	0.89	0.56	0.49
4-C super peak	3.71	2.80	2.50	4.90	3.01	2.61
4-C peak	2.80	2.12	1.89	3.70	2.28	1.97
4-C off peak	1.14	0.86	0.77	1.50	0.93	0.80
4-C super off peak	0.83	0.63	0.56	1.10	0.68	0.58

Table 33: Prices for Charging service and EV charging with ToU tariffs

Although the impact of having flat, 2-period, 3-period or 4-period ToU prices does not affect mileage cost, profiles with more charges in off-peak periods (Profile C) tend to have lower mileage costs than profiles with more charges in peak periods (Profile A), as **Figure 33** shows.

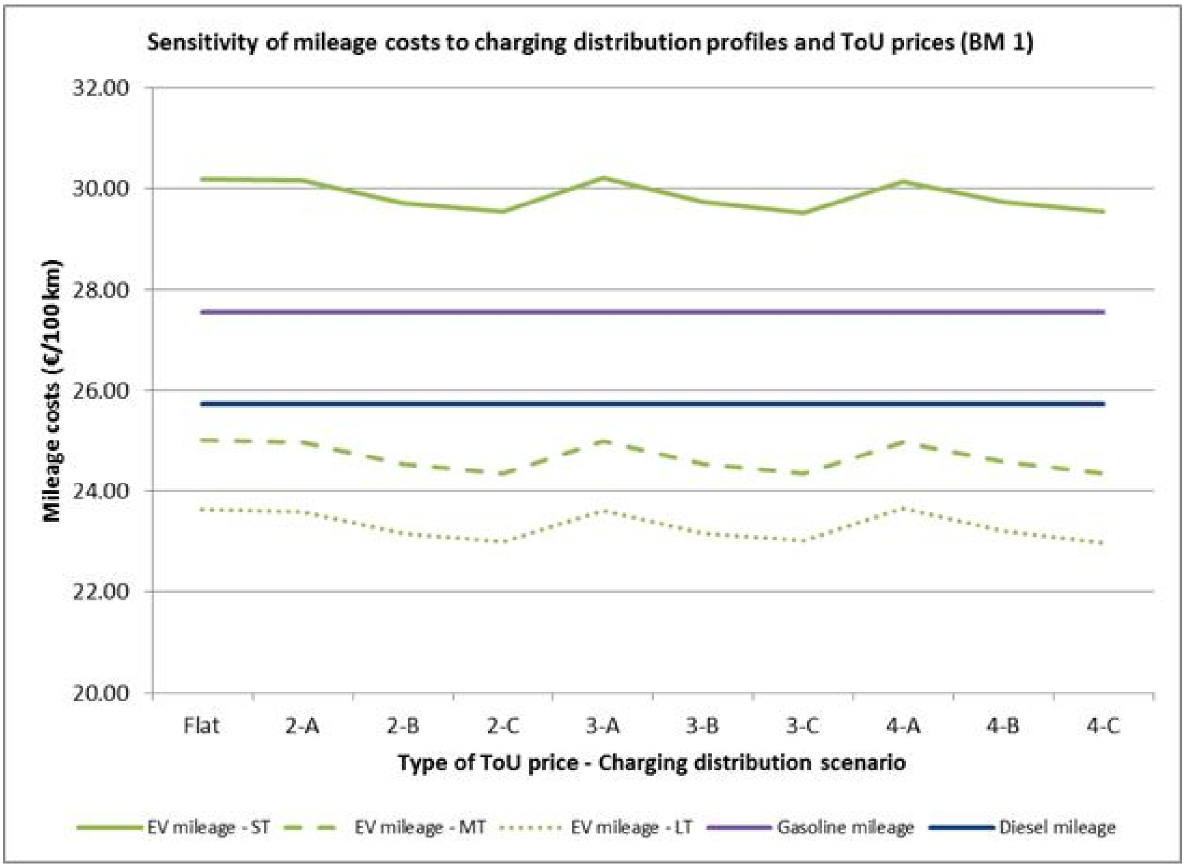


Figure 33: Evolution of EV mileage cost (BM 1, Sensitivity to ToU tariffs and charge distribution)

5 KPI Definition for all user levels of the ICT architecture

5.1 Introduction

The Green eMotion marketplace is an IT framework which allows business partners to buy and sell services related to electric mobility and provide a platform for deploying business cases around electric mobility. Service providers can define offerings which become available to service requesters (buyers) who can initiate and manage contracts through the system. The system will provide the technology backbone which will allow business partners to both buy and sell electric mobility and support services on a pan-European basis. The monitoring and evaluation of the performance of these services will provide insights into the most efficient ways to provide and implement these offerings. The level of performance must be considered for all users, including end users, administrators and the IT system itself. Moreover, monitoring of performance indicators (PI) and key performance indicators (KPI) will provide early insights into the relative success of various BMs and their suitability for use within the CH concept and beyond. PIs are metrics which provide an indication of the performance of a business unit or organisation as a whole.

This chapter draws from the content of [D3.3] and [D3.4] as a starting point in the selection and definition of PIs. [D3.3] defines the services and use cases (UCs) considered most likely to be delivered in demo regions as the market for electric mobility services matures. These offerings are envisaged to be the core parts of the emerging electric mobility service industry which will provide intelligent transport services as well as the framework which will allow businesses to offer inter-country travel options to customers. [D3.4] incorporates feedback from demo regions and the executive board as well as the lessons learned from the first release (release one) of the marketplace. It comprises a complete set of business requirements of Green eMotion, including those described in [D3.3], improved and enhanced features and UCs, improved structure and inclusion of additional UCs based on the feedback.

[D3.3] is the primary input for this work, providing the definitions of all services and UCs for which PIs are defined. [D3.4] is also a primary input for this chapter, providing the definitions of 25 additional UCs that are not described in [D3.3]. Much of the content contained here is derived from the requirement specifications laid out by the authors of [D3.3] and [D3.4], all of whom represent major stakeholders in the domain of electric mobility. This document (in particular, this chapter) can be used as a companion for [D3.3] and [D3.4] to provide a guide for monitoring the utility of any service implemented through the marketplace. This document describes 138 PIs covering 62 UCs.

After selecting the PIs from [D3.3] and [D3.4], the set of PIs was extended to cover measurement of performance of the ICT architecture at all user levels but also to support the data required for input to the BM assessment. Using these objectives, a set of KPIs were defined for all user levels.

5.1.1 Context within Green eMotion

The goal of WP9 is to determine the feasibility of large scale deployment of EVs across the EU and the multi-faceted impact that this will have throughout the region. This will be achieved by prior projection of predicted results into large scale models and assessment of real world information as deployment projects develop. One key aspect of this work is to determine the most suitable business approaches to EV deployment, allowing for a large scale and commercially sustainable roll out of the technology.

Accordingly, Task 9.3 is comprehensively evaluating the suitability of a number of BMs for use in the combined EV sale, electricity supply and mobility service spaces. This part of Task 9.3 evaluates aspects of these BMs within the context of the ICT marketplace framework. This provides a means for defining an assessment method of BM performance in practice, which will contribute to the objectives of WP9. Additionally, the work supplements the ICT specifications defined in WP3 by allowing for the evaluation of the system performance across user levels.

5.1.2 Input from WP3

The information contained in [D3.3] and [D3.4] consists of extensive descriptions of the main services considered necessary or likely to feature in the electric mobility marketplace in its first implementation. The 55 services are allocated to 114 UCs. These UCs are grouped into functional domains which broadly cover the functionality which must be offered to EV users in order to facilitate charging and travel throughout the EU. These functional domains are listed below in Table 34.

Core/platform marketplace services	This is the core functionality of the marketplace itself, which allows the provision of services defined in the other domains.
General e-mobility services	The general e-mobility services domain includes all charging and driving related basic and value added services spanning from identification and authorization, through EVSE service monitoring, payment settlements, search and reservation to sophisticated services such as intermodality planning and vehicle telemetry to cloud charging.
Roaming Domain	The roaming concept covers both international travel between country and provision of services across varying electric vehicle service providers (EVSPs) i.e. charging at any charge post regardless of the user's provider.
Energy Domain	This domain covers the management of power supply systems in large scale EV deployment scenarios. These services allow utilities to offer advanced grid management services.

Table 34: Functional domains used to group UCs

The UCs contained in [D3.3] and [D3.4] formed the starting point for the definition of PIs and KPIs. The set of indicators described in this document was developed by analysing the UCs to determine the most suitable metric for measurement and control of service performance.

Section 5.2 provides an explanation of the uses of the PIs and KPIs and their application to the marketplace ICT systems. The methodology employed is explained and the necessary inputs and terminology are also described. Section 5.3 covers the defined set of PIs and KPIs per functional domain. The details of each UC are presented and the associated sets of PIs and KPIs are defined. Annex II of this report relates to this section and provides additional information and relationships between the ICT users and the measurement of the various UC scenarios. A list of PIs and KPIs associated with each user is provided for easy reference for any stakeholder to review only the PIs and KPIs relevant to their own services and interactions. Additional information is also provided on the number of PIs and KPIs in each functional domain and the categories into which they are assigned.

5.2 Performance Indicators: Concept and Methodology

5.2.1 KPIs and PIs and how they are used

As already stated, PIs are metrics which provide an indication of the performance of a business unit or organisation as a whole. They are intended to provide a picture of the overall performance of an organisation and enables management to make adjustments to resources or services to maintain service performance expectations.

PIs provide managers with the high level information needed to determine if a business, system or process is operating within desired parameters. PIs can be both qualitative and quantitative, but should be measurable and actionable. They describe targets for the performance of a system, team or individual and are intended to provide a means of comparing real world performance against pre-determined targets in areas that are crucial to meeting the strategic goals of the organisation. They should be measured as often as possible with up to date information and reviewed regularly in order to allow for corrective action to be take when necessary.

PIs can be used for a variety of reasons within an organisation or team. The varied purposes can be both strategic and operational, aimed at aligning long-term performance with the organisation's vision or improving processes to meet targets. The following list provides a small number of examples of how PIs can be applied [PROV 2010].

- Development of a 'benchmark' for similar processes or services.
- Continuous improvement initiatives.
- Demonstrating and attributing business value from services.
- Evidential based improvement or changes to service delivery.
- Decision making for business and IT infrastructure planning.
- Development of Service Level Agreements (SLAs).

Selecting the information needed to assess the goals of a team or organisation is a vital part of determining a meaningful set of PIs. When choosing PIs it is important to first decide whom the indicator is intended for and how it will be used to assess performance and effect improvement by them.

The difference between KPIs and PIs relate to relevance. A set of KPIs is generally a subset of the full set of PIs and the KPIs will have been chosen to be the most important of the PIs in terms of performance impact. If the targets of KPIs, which have been selected from the set of PIs defined for each UC, are achieved, then the business or service will almost certainly be successful. In relation to the Green eMotion marketplace framework, a set of PIs have been defined for each electric mobility domain, evaluating the key services belonging to it in terms of cost, time, quality of service and service performance.

The core of the Green eMotion marketplace framework is essentially a service oriented architecture, which exposes business processes as services to end customers. This presents a multi-layered system for analysis in terms of process performance as there are both business process and IT systems which must be evaluated and controlled. In addition there are numerous user levels which engage with the marketplace, from administrators to business users, giving a broad range of scenarios for which KPIs and PIs must be defined.

The marketplace service performance must be measured using non-functional aspects of the EV service being offered. That is, the execution of the core marketplace service may be hidden from the parties involved in a business service transaction i.e. the buyer and seller. While the marketplace performance may be influential for the level of service experienced by end users, the focus of the PI defining performance from the point of view of the user will be different from that of the marketplace administrator. This is an important point for defining the focus of each PI and will be explained further in subsection 5.2.3.

The nature of the marketplace as an IT system in the business process pipeline presents the situation where, in order for the user experience to be of sufficient quality, the marketplace IT systems must offer a minimum quality of service (QoS). This introduces the concept of Service Level Objectives (SLOs), which are operational goals of a system such as the marketplace infrastructure, which the system must meet in order to facilitate the supply of other services. These SLOs should define what level of service should be provided at all user levels. While there are numerous metrics which are important for maintaining the QoS of the marketplace offering, these are not necessarily the default PIs.

Some metrics may only be used for internal process performance monitoring and never exposed to the customer, although often these PIs can coincide with customer focused measurements, with differing objectives for each user level. While PIs are traditionally used to measure the performance of a business in line with strategic goals, the nature of the marketplace offering is such that ICT requirements and service levels must also be considered.

The main objective of Green eMotion is to define a framework to facilitate the large scale roll out of electric mobility in Europe. A profitable and scalable marketplace IT system is a key component of this goal. Mass market electric mobility will require reliable ICT frameworks for infrastructure support, but also for supporting business offerings which can meet the demands of mobile, connected customers. Successful deployments of the technology will offer a large range of services which address the multiple functional areas of electric mobility and can be implemented across local and national boundaries. Performance measurement and analysis is essential for ensuring the efficient and reliable deployment of these services. By defining targets for quality and performance of services marketplace operators and partners can ensure a level of service which will support the goals of Green eMotion and ultimately lead to greater market penetration and the growth of electric mobility for mass market roll-out.

5.2.2 Inputs from WP3: Terminology

[D3.3] and [D3.4] were analysed in detailed in order to define a wide set of PIs and KPIs. The terminology used in this KPI analysis is taken directly from these deliverables. The actors in the system are persons using the software and marketplace (no systems). These actors interface with the marketplace to offer business services to other actors and also to administer the system. The potential business services, functionality to be implemented and interactions between actors are categorised and documented under the headings outlined in Table 35 below.

Business Scenario	High level description of possible business services with the use of the marketplace, its actors, values drivers, costs etc.
Feature	Textual description of each of the business services of a scenario. Features describe high level product/component functionality
Use Case	Description of the interaction of actors with the ICT system; comprehensive elaboration of features describing goals, scope, successful outcome, possible failures, work-flow and possible variations.

Table 35: Definitions of the headings included in the KPI definitions

Each UC and actor is assigned a specific identification (ID) number in [D3.3]. These ID numbers are used here along with the UC definitions in order to provide a consistent reference to the actors and service offerings defined in the marketplace specifications.

These terms are used extensively throughout Annex II with reference to the unique ID numbers given for each actor, UC and feature in [D3.3] and [D3.4]. Readers may refer to these deliverables for a complete description of each UC and a full definition of each actor.

5.2.3 Methodology

A systematic approach was taken when defining the set of metrics presented in Annex II. Each functional domain listed in [D3.3] and [D3.4] was analysed on a UC level.

A key metric was defined for the primary actor(s) for a UC if it was deemed that the definition of a PI would have value in terms of assessing the QoS. This approach ensured that the metrics defined were relevant to the services employed and their context within the ICT system. While further actors could define additional PIs for measuring the performance of a service within a UC, these will be specific to the actor's organisation.

In each functional domain there are a range of user levels considered, from IT administrator to business user. Accordingly a broad mix of metrics is required to assess the performance of the marketplace architecture for all levels. These range from quality of service metrics linked to SLOs to service specific business process metrics.

The details of each actor, UC, feature and business scenario were captured in a Microsoft Access database. A set of unique of PIs were defined for all UCs. These metrics can be linked to actors, feature sets and business scenarios to provide a comprehensive resource for service performance management at a range of levels. These PIs are presented in Annex II per UC.

The set of metrics presented offer a low level of granularity for assessing performance of numerous planned usages of the marketplace IT system. KPIs can be defined by choosing among the numerous lower level operational metrics which monitor IT system performance. **Figure 34** below illustrates the concept of defining higher level strategic PIs using both operational PIs and granular process metrics.

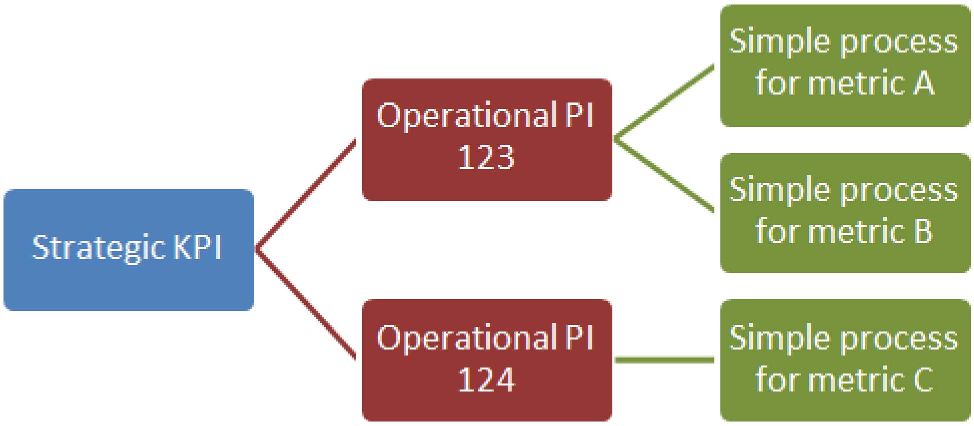


Figure 34: PI and metric aggregation for high level indicators

The measurement method for the underlying data required for each PI and KPI is not defined in this document. Further development of this set of metrics will require specification of data sources and the frequency and method of measurement. Detailed definitions of PIs and their measurement methodology will be possible at a later stage, ideally based on Web Services Description Language specifications for ICT level KPIs and PIs. Target value ranges are not defined for the PIs and KPIs presented here, given the early stage of the marketplace ICT specification.

5.3 Typologies of PIs and KPIs

In many cases, different members of an organisation or team may focus on different aspects of the company or system, and therefore will need different information to assess performance. It is therefore useful to group PIs and KPIs into categories which address varying operational and business aspects which may be of interest. Grouping PIs and KPIs into categories can assist with testing the relevance and of metrics to a particular area.

The broad categories into which the set of PIs and KPIs were grouped are explained below:

- Cost: The monetary cost of service provision or usage. This is assessed from the point of view of the primary actor in the UC. The approach assumes that the necessary infrastructure and services are already in place and measures the marginal cost of events.
- Time: PIs in this category address IT system response times, service availability times, service employment times and business service process times. This provides a wide range of engagement levels and measurement time frames for assessment. While the focus of the PIs spans sub-second IT responses to long term equipment availability, each of these PIs provides an important measure of the level of service provision in each UC.
- Quality of service (QoS): The QoS metrics primarily address performance of the IT systems. These cover multiple functional domains including charging infrastructure, communications and

the core marketplace services. These PIs focus on fault tracking and success rates in the delivery of backend services which underlie many of the business process services considered in the UCs. Of particular interest to users at the administrator level, the management of QoS metrics can be linked to more intangible aspects of end user experience and service uptake.

- Service performance: The service performance category covers PIs which measure the utilisation of services within the relevant functional domain. These metrics assess the uptake of services and engagement level of end users. Additionally there are metrics defined in this category which measure the growth of these services and increases in user numbers. Service performance is monitored in terms of the utilisation level of the offering and expansion of the user base, indicating if the service is viable as a proposition to end users. Technical and financial details of service implementation are not assessed in this category.

An overview of the categorisation of the PIs with some examples is presented in Table 36. Also shown in this table is the format of the PIs and for what they will be used as input e.g. the BMs, quality management or planning of services. In the first case in the table, the PI, 'roaming cost per charging event' is defined as the PI, it is in the Cost category, its unit will be in €, it will be used in the BMs, its ID number is PI-7 and the user level is the EVSP. The full set of PIs is presented in Annex II.

Category	Example	ID	Description	Format	Input for
Cost	Roaming cost per charging event	PI-7	Measures the cost of event	€	BMs
Time	Average time it takes to identify and authenticate a user	PI-2	IT response time, service availability time, service employment time, business service process time	Time frame	Quality management EV-driver convenience
Service performance	Number of EVSE registered in the marketplace	PI-124	Growth of services and increases in user numbers	numbers	BMs
QoS	Percentage of search results which cannot be fulfilled	PI- 61	Fault tracking and success rates	%	Quality management Planning of services

Table 36: Categorisation of PIs and examples of their use

5.4 Definition of Key Performance Indicators (KPIs)

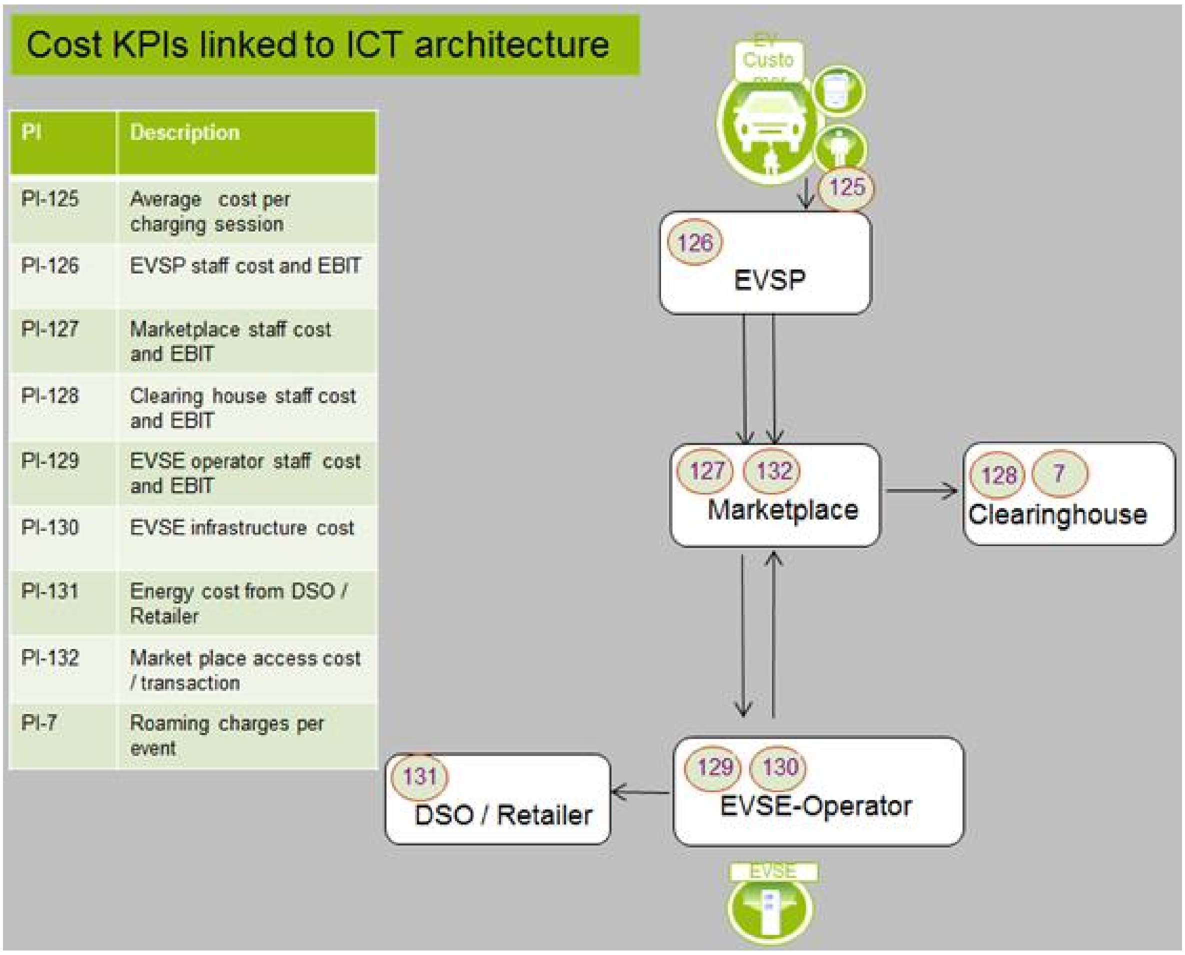
From the list of PIs developed from WP3 and the list of PIs required by the BMs, a selection of KPIs was made using input from the partners involved in WP3 and in consultation with the partners in WP9.3. The KPIs were selected on the basis of the following criteria:

1. Relevance and importance to the user in terms of cost, time, QoS or service performance.
2. Most important in terms of planning of services (e.g. if many drivers were not able to find an EVSE in a location, the KPI would inform the providers that more EVSEs were needed).
3. Input requirement to the BMs (mostly Cost type KPIs).

The following two subsections cover the KPI definitions in the different categories linked to the ICT architecture and the mapping of the KPIs from the BMs to the Green eMotion building blocks, for different user levels in both cases.

5.4.1 Definition of KPIs linked to the ICT Architecture

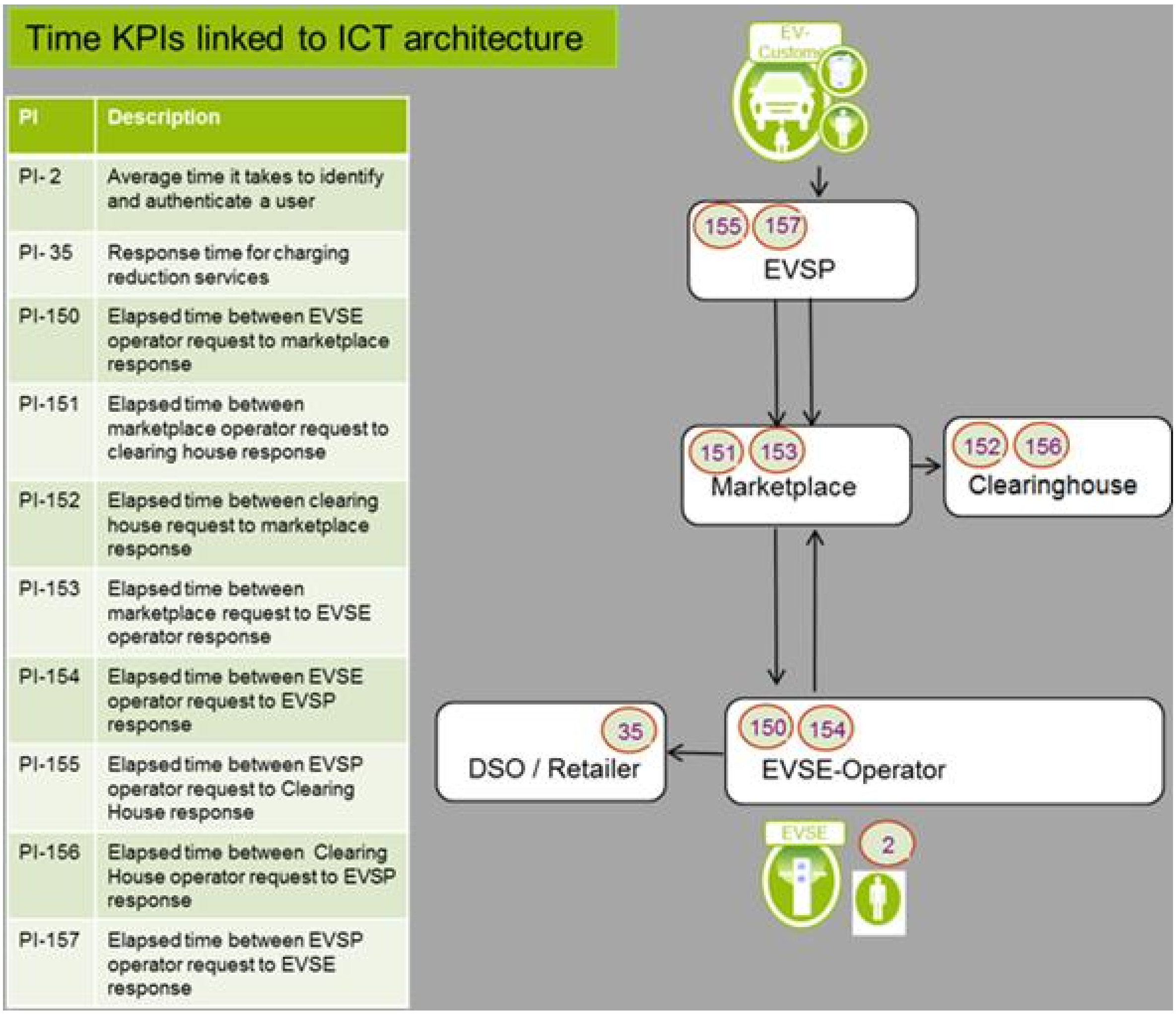
The first set of KPI definitions is in the cost category. They are listed and mapped to the different user levels in **Figure 35**. The KPI ‘average cost per session’ (PI-125) applies at the customer level and, at the EVSP level, the KPI ‘EVSP staff cost and EBIT’ (PI-126) is considered a significant cost measure. At the marketplace level, two KPIs are defined: ‘the marketplace staff cost and EBIT’ (PI-127) and the ‘marketplace access cost / transaction’ (PI-132). At CH level, the ‘clearing house staff cost and EBIT cost’ (PI-128) and ‘roaming charges per event’ (PI-7) have been selected as the KPIs. In the case of the EVSE operator level, the ‘EVSE operator staff cost and EBIT’ (PI-129) and the ‘EVSE infrastructure cost’ (PI-130) have been selected as KPIs. Finally, in the case of the DSO/Retailer level, the ‘energy cost’ (PI-131) is considered the most significant indicator.



PI	Description
PI-125	Average cost per charging session
PI-126	EVSP staff cost and EBIT
PI-127	Marketplace staff cost and EBIT
PI-128	Clearing house staff cost and EBIT
PI-129	EVSE operator staff cost and EBIT
PI-130	EVSE infrastructure cost
PI-131	Energy cost from DSO / Retailer
PI-132	Market place access cost / transaction
PI-7	Roaming charges per event

Figure 35: Cost KPIs linked to ICT architecture

The next set of KPIs defined were those in the category of time. They are listed and mapped to the ICT architecture in **Figure 36**. At the EVSE user level, the ‘time it takes to identify and authenticate a user’ (PI-2) is defined as the first KPI in the time category. This KPI in itself, while useful, is not informative in terms of identifying in which part of the architecture there is a delay, when the process is not running smoothly. To help locate where delays arise, the KPIs PI-150, PI-151, PI-152, PI-153, PI-154, PI-155, PI-156, PI-157 have been. Each measures the time it takes for each of the different parts of the system to deal with the transaction. Finally, the ‘response time for charging reduction services’ (PI-35) is another KPI identified as being a significant time indicator at the DSO/Retailer level.

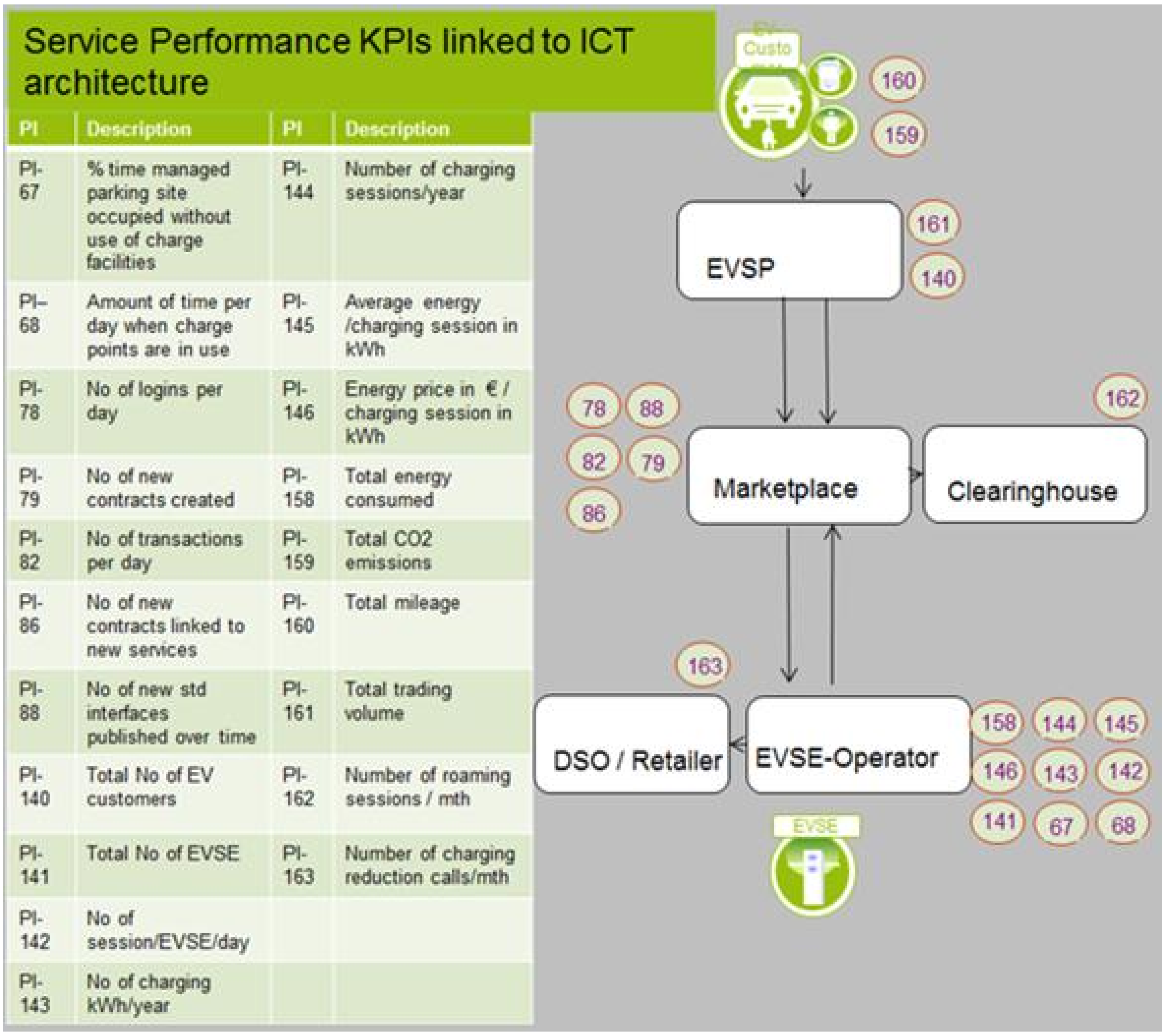


Time KPIs linked to ICT architecture

PI	Description
PI-2	Average time it takes to identify and authenticate a user
PI-35	Response time for charging reduction services
PI-150	Elapsed time between EVSE operator request to marketplace response
PI-151	Elapsed time between marketplace operator request to clearing house response
PI-152	Elapsed time between clearing house request to marketplace response
PI-153	Elapsed time between marketplace request to EVSE operator response
PI-154	Elapsed time between EVSE operator request to EVSP response
PI-155	Elapsed time between EVSP operator request to Clearing House response
PI-156	Elapsed time between Clearing House operator request to EVSP response
PI-157	Elapsed time between EVSP operator request to EVSE response

Figure 36: Time KPIs linked to ICT architecture

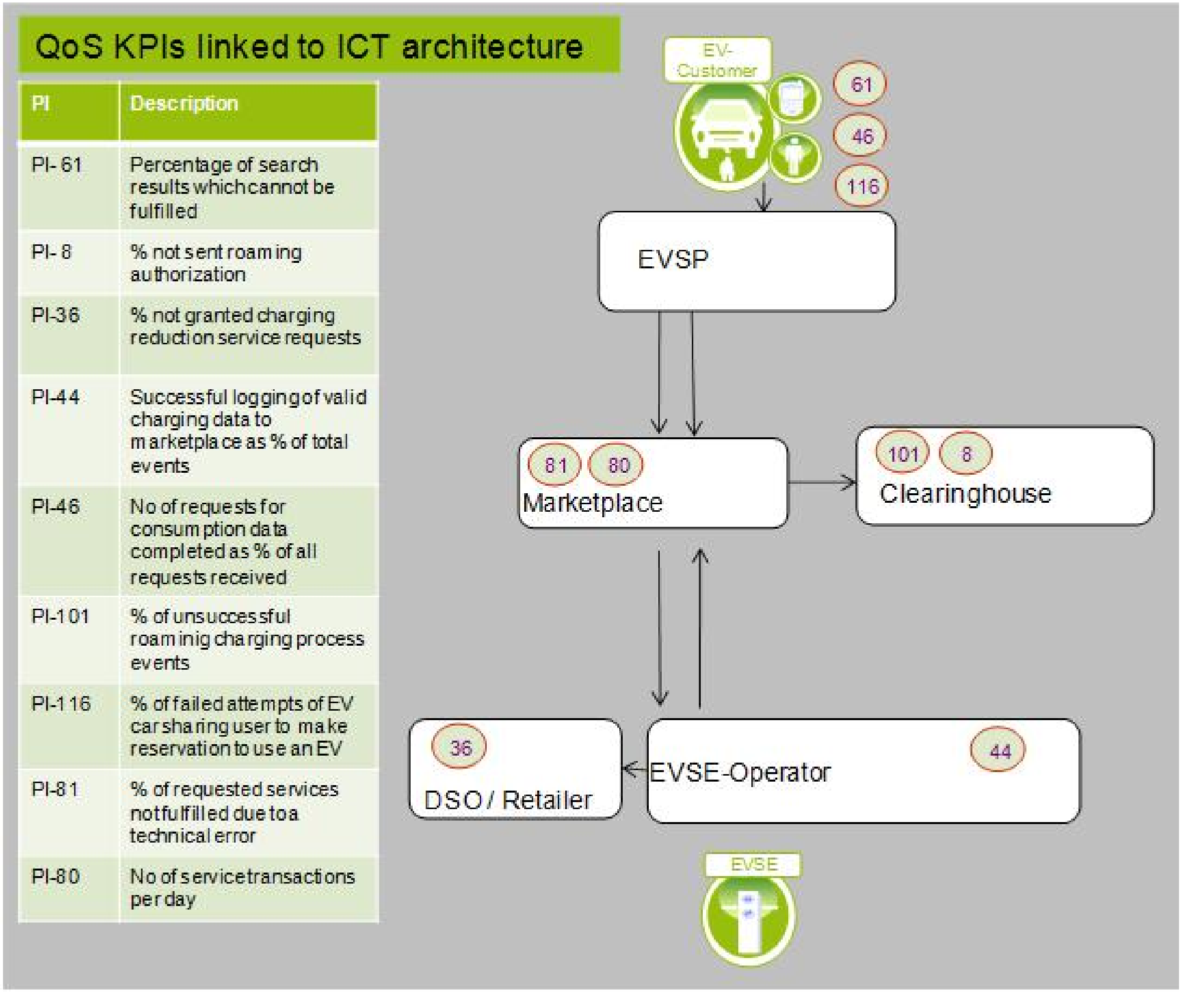
In recognition of the importance of service performance, a large number of KPIs has been selected in this category. Some of them are also useful in terms of input to the BMs e.g. 'total mileage' (PI-160), 'total trading volume' (PI-161) and 'total number of EVSE' (PI-141). These KPIs and the others in this category are shown in **Figure 37** and mapped to the appropriate user level. At marketplace level, the 'number of logins per day' (PI-78), the 'number of new contracts created' (PI-79), the 'number of transactions per day' (PI-82), the 'number of new contracts linked to new services' (PI-86) and the 'number of new standard interfaces published over time' (PI-88) are useful key measures. At CH level, the KPI 'the number of roaming sessions/mth' (PI-162) has been selected and the 'number of charging reduction calls/mth' (PI-163) has been identified as key for the DSO/Retailer level. At the EVSE Operator level, the following KPIs have been identified: the 'percentage time a managed parking site has been occupied without the use of the charge facilities' (PI-67), the 'amount of time per day when charge points are in use' (PI-68), the 'total number of EVSE' (PI-141), the 'number of sessions/EVSE/day' (PI-142), the 'number of charged kWh/year' (PI-143), the 'number of charging sessions per year' (PI-144), the 'average energy used / charging session kWh' (PI-145), the 'energy price in €/charging session in kWh' (PI-146) and the 'total energy consumed' (PI-158).


Service Performance KPIs linked to ICT architecture

PI	Description	PI	Description
PI-67	% time managed parking site occupied without use of charge facilities	PI-144	Number of charging sessions/year
PI–68	Amount of time per day when charge points are in use	PI-145	Average energy /charging session in kWh
PI-78	No of logins per day	PI-146	Energy price in € / charging session in kWh
PI-79	No of new contracts created	PI-158	Total energy consumed
PI-82	No of transactions per day	PI-159	Total CO2 emissions
PI-86	No of new contracts linked to new services	PI-160	Total mileage
PI-88	No of new std interfaces published over time	PI-161	Total trading volume
PI-140	Total No of EV customers	PI-162	Number of roaming sessions / mth
PI-141	Total No of EVSE	PI-163	Number of charging reduction calls/mth
PI-142	No of session/EVSE/day		
PI-143	No of charging kWh/year		

Figure 37: Service performance KPIs linked to ICT architecture

The final category for which a set of KPIs was chosen is quality of service (QoS). These KPIs are described in **Figure 38** and mapped to the appropriate user level within the ICT architecture. Three have been selected at EV customer level: the 'percentage of search results which cannot be fulfilled' (PI-61), the 'number of requests for consumption data completed as a percentage of all requests' (PI-46) and the 'percentage of failed attempts of EV car sharing user to make a reservation to use an EV' (PI-116). Two KPIs have been selected at the marketplace user level: the 'percentage of requested services not fulfilled due to a technical error' (PI-81) and the 'number of service transactions per day' (PI-80). At CH level, the 'percentage of unsuccessful roaming charging process events' (PI-101) and the 'percentage of individuals not sent roaming authorisation' (PI-8) have been selected. The QoS KPI at EVSE operator level is 'successful logging of valid charging data to the marketplace as a percentage of the total events' (PI-44) and at the level of the DSO/Retailer the 'percentage not granted charging reduction service requests' (PI-36) KPI is considered important.



PI	Description
PI- 61	Percentage of search results which cannot be fulfilled
PI- 8	% not sent roaming authorization
PI-36	% not granted charging reduction service requests
PI-44	Successful logging of valid charging data to marketplace as % of total events
PI-46	No of requests for consumption data completed as % of all requests received
PI-101	% of unsuccessful roaminig charging process events
PI-116	% of failed attempts of EV carsharing user to make reservation to use an EV
PI-81	% of requested services not fulfilled due to a technical error
PI-80	No of service transactions per day

Figure 38: Quality of Service KPIs linked to ICT architecture

5.4.2 KPIs from the BMs mapped on the Green eMotion Building Blocks

Three different categories of KPIs were mapped from the BMs to the Green eMotion building blocks (see **Figure 3**). The KPIs in the first category were those of cost and the mapping for this is presented in **Figure 39**. At the level of the EVSE operator, the 'EVSE staff cost and EBIT' (PI-129), the 'EVSE infrastructure cost' (PI-130) and the 'EVSE maintenance and operation costs per year' (PI-137) are identified as key. The 'market place costs' (PI-135) and the 'clearinghouse costs' (PI-136) have also been defined as KPIs. Finally within this category, the 'EVSP costs per year' and the 'energy costs per year' have been identified for the EVSP and DSO/Retailer levels respectively.

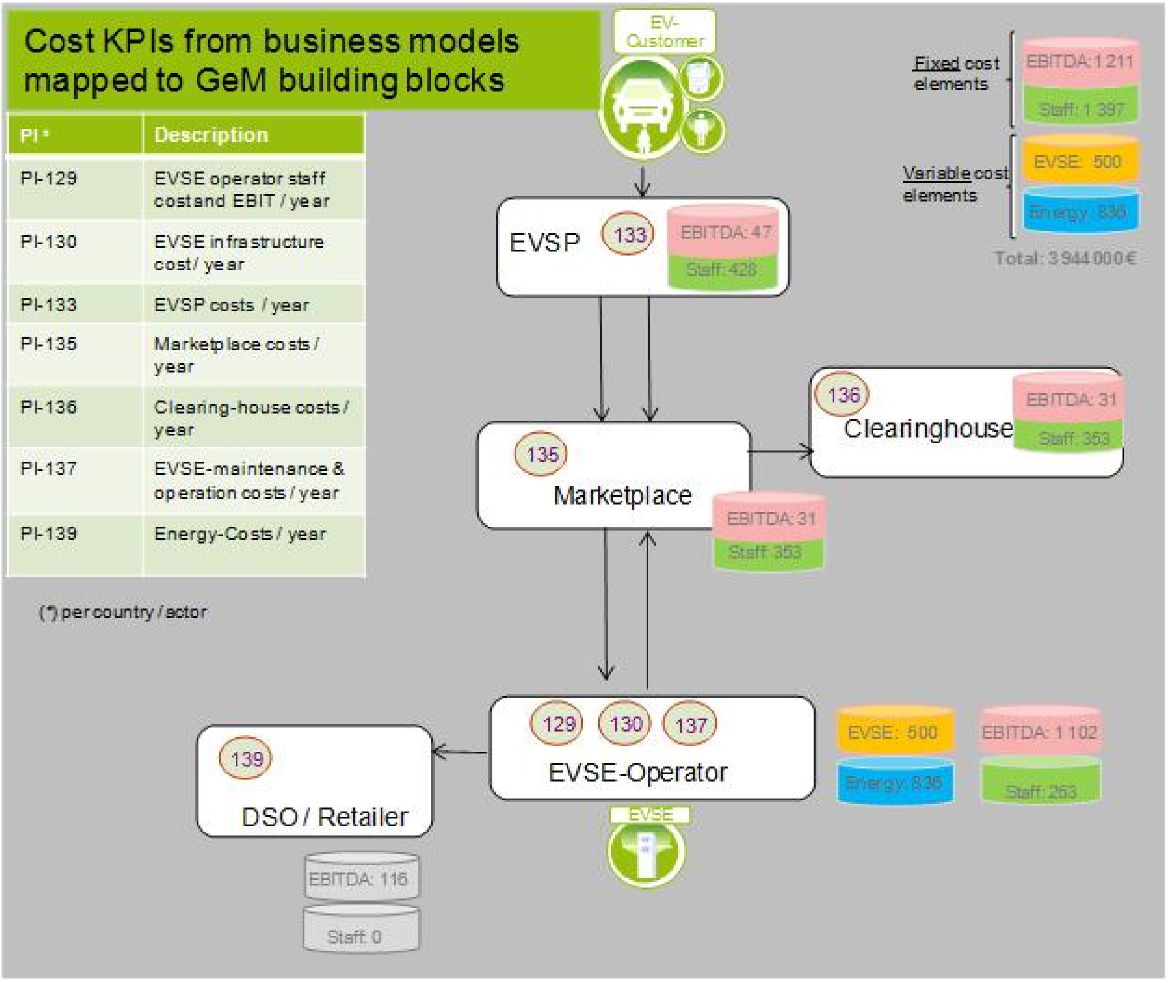


Figure 39: Cost KPIs from BMs mapped to the Green eMotion building blocks

The second category of KPIs mapped to the Green eMotion building blocks from the BMs were those relating to the operations. The mapping is shown in **Figure 40**. At EVSP level, the 'total number of EV customers' (PI-140) and the 'number of sessions / EV customer / day' (PI-141) are selected. At the level of the DSO/Retailer, the 'number of charging kWh/year' (PI-143) was identified as key. Five KPIs were selected for the EVSE-operator level: the 'total number of EVSEs' (PI-124), the 'number of sessions EVSE / day' (PI-142), the 'number of charging kWh per year' (PI-143), the 'average energy / charging session in kWh' (PI-145) and the 'energy price in € /charging session in kWh' (PI-146).

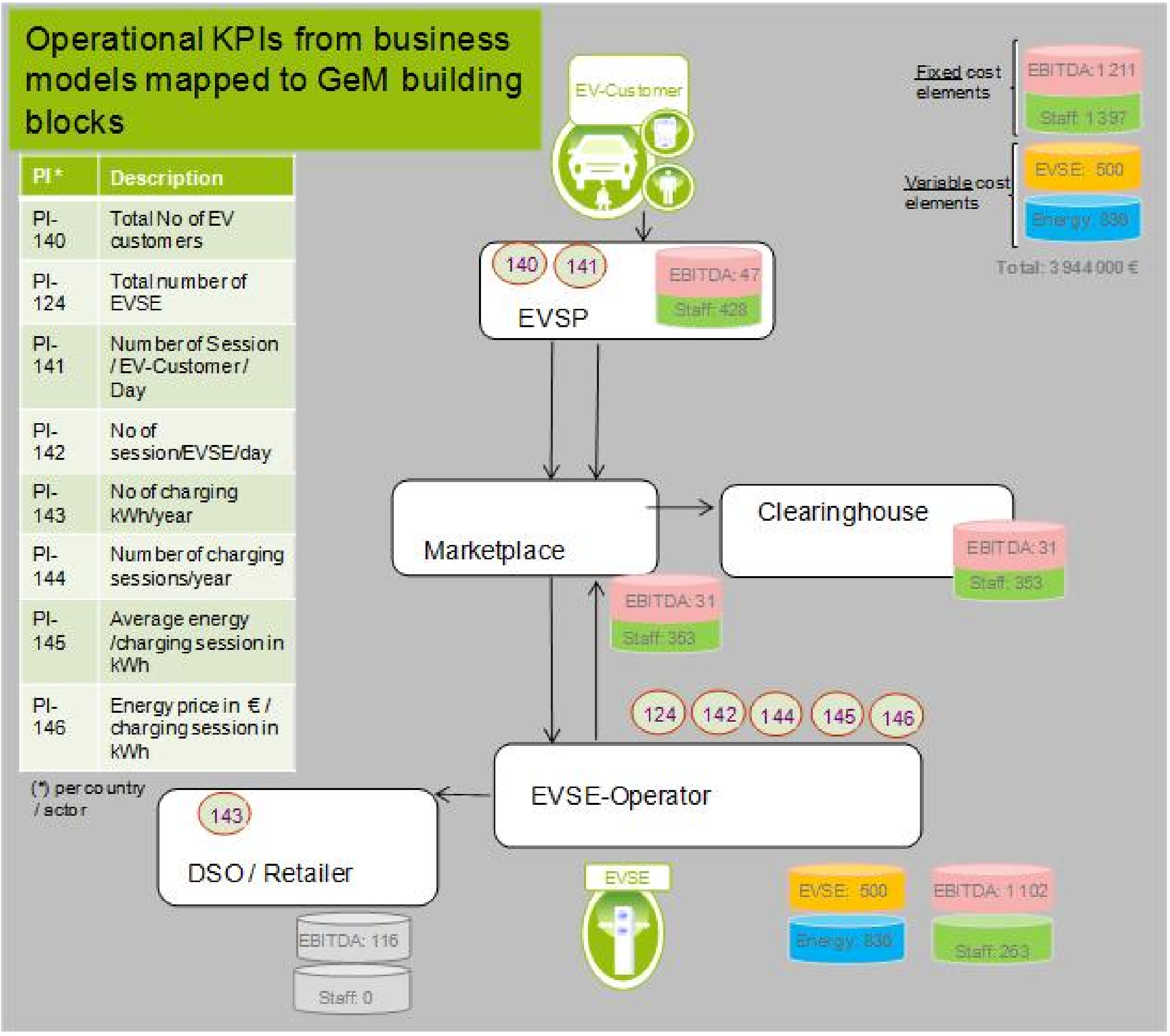


Figure 40: Operational KPIs from BMs mapped to the Green eMotion building blocks

The third category of KPI examined was that related to roaming services and the mapping for this is presented in **Figure 41**. At EVSP level, the 'percentage of search results which cannot be fulfilled' (PI-61), the 'total cost of roaming services' (PI-7) and the 'percentage CDR containing wrong but consistent data' (PI-10) were selected as the KPIs to be used. In the case of the EVSE operator, seven KPIs were selected: the 'percentage of customers not sent roaming authorisation messages' (PI-8), the 'identification and authorisation time' (PI-2), the 'number of charging sessions per year' (PI-9), the 'percentage of time a managed parking site is occupied by a non-EV' (PI-67), the 'number of requests for consumption data completed as a percentage of all requests received' (PI-46), the ' number of requests for CO2 emissions successfully calculated and logged as percentage of total' (PI-45) and the 'successful logging of valid charging data to the marketplace as a percentage of total events' (PI-44).

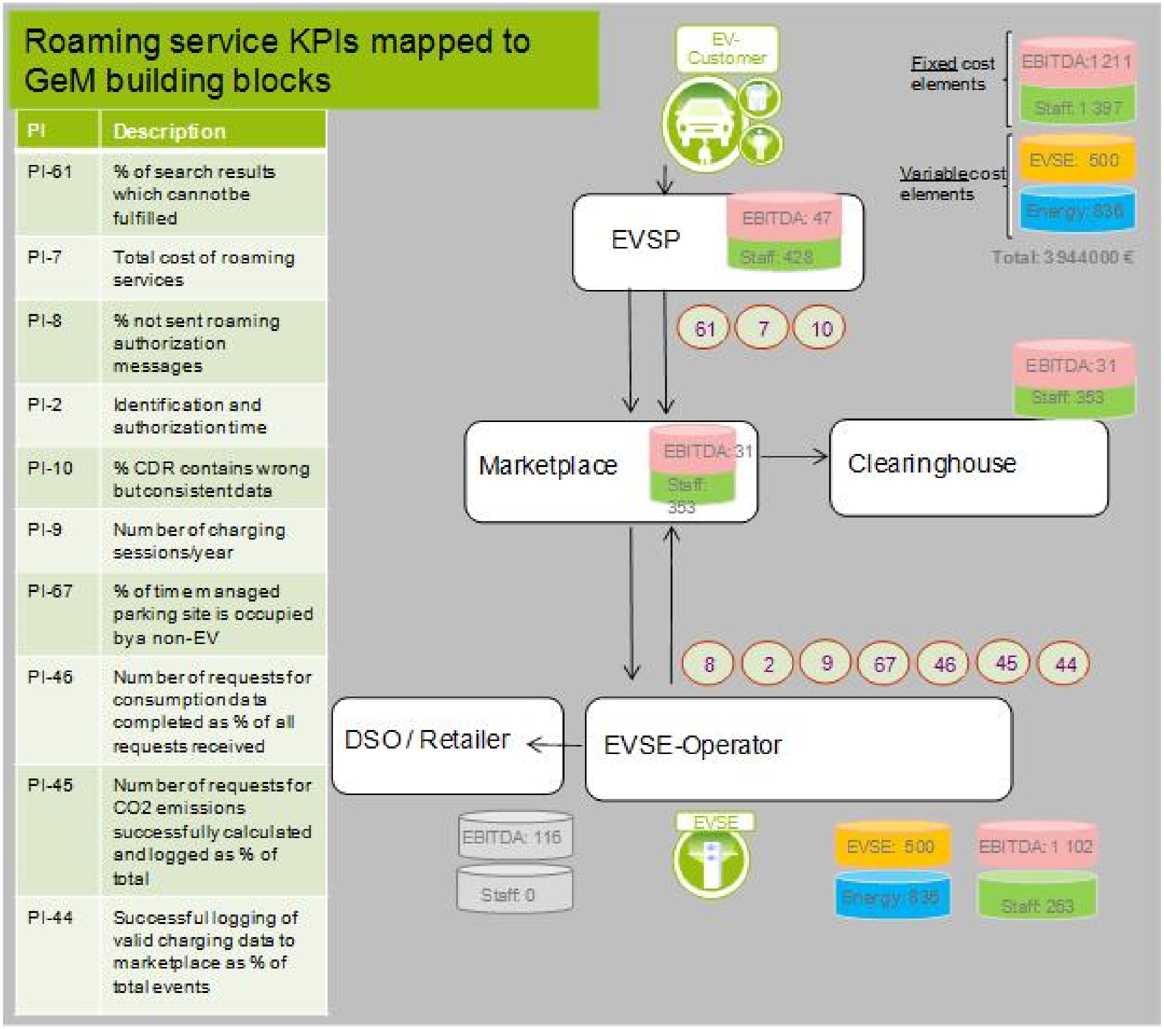


Figure 41: Roaming service KPIs mapped to the Green eMotion building blocks

6 Summary and discussion

This document presents the economic assessment of the electric mobility business models (BM) within Green eMotion project, as part of Task 9.3. A second version of this report will be delivered in February 2015.

Beside the economic performance, also the quality and effectiveness of electromobility services provided by using the Green eMotion ICT architecture needs to be evaluated. Therefore a set of key performance indicators (KPIs) was defined in the categories of 1) Cost 2) Time 3) Quality of Service and 4) Service Performance. Linking of the KPIs to the ICT architecture has been completed at all user levels. The cost, operational and roaming KPIs from the BMs have been mapped on to the Green eMotion building blocks. The KPIs will facilitate the assessment of the suitability of various BMs for their use in the ICT marketplace framework. Measurement of many of the KPIs has been difficult to date because the market is in its early stages. However, the possibility of measurement will be examined further in the coming months within the Green eMotion Project.

A methodological approach has been followed to select the BMs to be considered. Then, a number of graphical models have been created to more easily represent the economic interrelations of the different stakeholders involved in the business network. Three business models were evaluated: basic charging, EVSE reservation and congestion/load management. Based on those graphical representations, an economic assessment tool has been developed, which has been used to calculate the economic performance of the different stakeholders for the basic charging service.

The objective of the analysis was to check whether there was any scenario in which the provision of charging services for electric vehicles could bring economic benefits to all the involved stakeholders, from the Clearing House and the Marketplace Operator, going through the EVSE Operator and the EVSP, to the EV customers.

In the unbundled business model for the service “basic charging” the DSO, the electricity retailer, the EVSP and the EVSE operator are different legal entities. They have contracts in place that finally allow the EVSP to offer charging services to the EV customer (EV driver) using the EVSEs of the EVSE operator. As a result the EVSE operator has the possibility to bill the EVSP for the charging event. The business process of clearing will be done by a Clearing House connected to a marketplace. The outcomes presented are therefore related to an unbundled business model where all actors are independent from each other.

One of the most difficult tasks was the selection of the data to be used for the economic assessment, since the EV market is still in its first steps and existing experiences are almost always linked to demonstration projects, whose performance is not likely to be the same as when mass-market introduction is reached. Therefore, in addition to the data collected in the demo regions included in Green eMotion (WP1) and by literature review, a number of workshops, meetings and phone conferences were held with the industrial partners involved in the project, so that their views about future businesses around electric mobility could be included in the analysis.

Some parameters are assumed to have an evolution in the next years, so three scenarios have been defined for the short-term (ST), medium-term (MT) and long-term (LT). These scenarios do not aim at forecasting the likely situations in the future, but to establish a reference framework for the analysis and to be able to extract conclusions on the impact of the different parameters, see Table 37.

	ST	MT	LT
Number of EV customers	5 000	50 000	250 000
Number of EVSE	1 000	10 000	50 000
EVSE installation cost (€) [NPE 2011]	6 500	5 600	4 700
Civil work	*2 000*	*2 000*	*2 000*
Grid connection	*1 500*	*1 500*	*1 500*
Hardware	*3 000*	*2 100*	*1 200*
Add-on cost of an EV compared to an ICEV (€)	2 000	500	0
Purchase cost	*5 000*	*3 500*	*3 000*
O&M costs during the whole EV lifetime	*-3 000*	*-3 000*	*-3 000*

Table 37: EV charging scenarios (BM 1, Base)

By using the parameters presented in Table 10 (see chapter 3.5), in Table 12 (see chapter 4.1), in Table 37 (see also Table 13 in chapter 4.1), and by setting the minimum desirable profit level for each actor at 10% of its annual expenditures (staff, overheads, O&M and annuitized investment), the minimum prices for the exchanged objects are presented in Table 38 (see also Table 14 in chapter 4.1).

Item	Payment from actor to actor	ST	MT	LT
Clearing price (€/clearing event)	Marketplace Operator → CH	0.22	0.04	0.02
Marketplace access price (€/access to the marketplace)	EVSE Operator → Marketplace Operator EVSP → Marketplace Operator	0.22	0.04	0.02
Charging service price (€/charging)	EVSP → EVSE Operator	1.71	1.33	1.20
EV charging price (€/charging)	EV customers → EVSP	2.20	1.42	1.25

Table 38: EV pricing scenario evolution in the three scenarios (BM 1, Base)

In the short-term scenario we assume that 5000 EVs charge publicly every day and 5 EVs share 1 public charger. Under these conditions the EV driver would have to pay a customer end price of 2.20 € per public charging. With 50 000 public charging events every day (mid-term scenario) the price decreases to 1.42 € and with 250 000 charging events (long-term scenario) it reduces to 1.25 €. Even if the price in the short-term scenario is rather high, 1.42 € in the mid-term scenario seems to be acceptable. The main issue is how and where we can achieve 5 fee-based public charging events per day per public charger.

The typical EV owner in the short and mid-term will presumably be prosperous and most likely he will have the possibility for home charging. Public charging is much more expensive than home charging, where the customer will only pay the normal tariff for electricity. Therefore the EV driver will use home charging whenever possible. Let us presume the EV driver will use home charging in 90% of the cases and public charging for the remaining 10% and calculate the total number of cars in a region necessary to cover the costs for the public charging infrastructure.

In the mid-term scenario we assumed 50 000 public charging events per day. With 10% of all charging events being public, that leads to 500 000 charging events per day – home and public together. If each EV customer charges once per day (home and public), we need 500 000 EV customers. Those 500 000 customers would share 10 000 public chargers in the mid-term scenario (50 customers per charger).

In 2012 the region of Madrid had 6.4 Mio inhabitants [Eurostat 1], 3.3 Mio passenger cars [Comunidad de Madrid] and an area of 8 028 km^2 [Eurostat 2]. So for the region of Madrid, being the third-largest European metropolitan area after Paris and London [Demographia], the profitable business presented in the medium-term scenario (500 000 cars, 10 000 public chargers) would require that 15% of the passenger cars were electric and that one charger was installed in each 0.8 km^2 or 900 m*900 m.

A sensitivity analysis of the described business case shows that the parameter with the biggest impact on the profitability of the different stakeholders is the usage of public EVSE. If we set the number of charging events per customer per day to one, we can calculate the end customer price for public charging as a function of the utilization in the different time horizons.

In the short-term scenario, meaning 5 000 public charging events per day at 1 000 EVSE, the end customer price for public charging is 2.2 € as already described in the base scenario. This price increases to 3.3 € if the utilization of the EVSE reduces to 2 500 public charging events per day.

In the mid-term scenario, meaning 50 000 public charging events per day at 10 000 EVSE, the end customer price for public charging is 1.42 € as already described in the base scenario. This price increases to 2.2 € if the utilization of the EVSE reduces to 25 000 public charging events per day. For more details see chapter 4.2.4.

Beside the fact that we need a high number of EV customers in the market and them to share a limited number of public chargers, they must be willing to pay for the usage. This is difficult to achieve as in residential, medium to small urban areas and rural areas, drivers are not used to pay for parking at all. Also, several EU municipalities are already supporting EV uptake through free parking.

These results lead to the conclusion that the business case of public charging can only be profitable within such mid-term business scenario in case of highly frequented EVSEs which are located at points of interest, so that people are willing to pay for the usage and usage time is short enough to allow for several charging events per day. Outside of this niche, the end customer pricing model looks non-competitive against conventional transportation.

The upcoming second report on business model analysis will focus on infrastructure with selected features like location at point of interest or fast charging at highways. It will be analysed which part of the public charging business might show a positive business case in the mid-term future, considering the whole stakeholders value chain.

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8 Annex I: Other methodological considerations

In different sections of this deliverable, reference is made to [IR 9.3.1]. As this interim report is not a public document, a summary of its most relevant content is made in this annex.

On the other hand, the analysis presented in the core of D9.4 focuses on the Independent EVSE Operator market model, the roaming of charging service scenario and the contracting through the marketplace. This annex presents the graphical models and the relationships for other market models, roaming scenarios or contracting modes. The process to build up the economic assessment tool for these alternatives is the same as the one presented in Chapter 3.

8.1 Graphical modelling of business cases

8.1.1 Introduction to e^{3}value methodology

When many actors, with different interests, exchange value with each other, business cases can become rather complex.

The analysis of such businesses through traditional methods may result either time-consuming, or oblige to perform simplifications that usually hide important implications of the business for some of the involved actors. In order to overcome such problems, the e^{3}value methodology was created and adapted to the world of distributed generation and other Distributed Energy Resources (DER).

This methodology provides a pre-defined template to describe the business idea at hand, together with a financial analysis, based on investment and operational cash-flow perspective, and a scenario approach. What is more, the methodology offers a common understanding of the business case, because it uses a shared and well-defined terminology, available for every stakeholder involved in the business case.

The methodology uses, on the one hand, well-established business modelling methodologies for networked enterprises and, on the other hand, traditional economic investment assessment techniques such as calculation of Net Present Value (NPV) and Internal Rate of Return (IRR).

The main features of the methodology are that it presents the whole picture of the business case and that it focuses on the concept of economic value. This way, the business cases are represented graphically, showing all the actors which are needed to run the BM (including the business developers, regulated actors and competitors) and the economic relationships between them.

The e^{3}value methodology provides modelling concepts for showing which parties exchange objects of economic value with whom, and what they expect in return. The conceptualisation of a business idea can be graphically represented in a rigorous and structured way, as **Figure 42** shows:

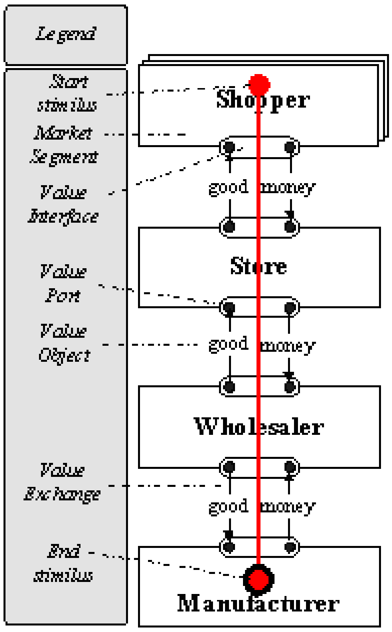


Figure 42: Simple example of an e^{3}value model

The most important concepts of the e^{3}value methodology are listed below:

- **Actor**: An actor is perceived by its environment as an independent economic (and often also legal) entity. An actor makes a profit or increases its utility. In a sound and sustainable BM each actor should be capable of making profit. In electric systems, there is a common set of actors, such as producer, distribution system operator, transmission system operator, government, supplier, balancing groups, energy service companies, metering companies…
- **Value Activity**: The electricity sector performs several value activities, namely, generation, transmission, distribution, supply, system operation…
- **Value Object**: Actors exchange value objects, which are services, products, money, or even consumer experiences. The important point here is that a value object is of value for one or more actors.
- **Value Port**: An actor uses a value port to show to its environment that it wants to provide or request value objects. The concept of ports enables us to abstract away from the internal business processes, and to focus only on how external actors and other components of the BM can be 'plugged in'.
- **Value Offering**: A value offering models what an actor offers or requests from its environment. The closely related concept 'value interface' (see below) models an offering to the actor's environment and the reciprocal incoming offering, while the value offering models a set of equally directed value ports exchanging value objects. It is to model e.g. bundling: the situation that some objects are of value only in combination for an actor.
- **Value Interface**: Actors have one or more value interfaces, grouping individual value offerings. A value interface shows the value object an actor is willing to exchange in return for another value object via its ports. The exchange of value objects cannot be divided at the level of the value interface.
- **Value Exchange**: A value exchange is used to connect two value ports with each other. It represents one or more potential trades of value objects between value ports.

- **Market Segment**: The market segment shows a set of actors that, for all of their value interfaces, give the same economic value to objects.

The concepts above can be used to model value exchanges between actors or market segments, but do not give the idea of which value activities or value exchanges must take place, so that some other value activities or value exchanges can also take place. In other words, they do not represent the order in which value exchanges must take place. To that end, some other concepts used in an existing scenario technique called Use Case Maps (UCM), are presented below:

- **Scenario path**: A scenario path consists of one or more segments related by connection elements and start and stop stimuli. A path indicates via which value interfaces objects of value must be exchanged, as a result of a start stimulus, or as a result of exchanges via other value interfaces.
- **Stimulus**: A scenario path starts with a start stimulus, which represents a consumer need. The last segment(s) of a scenario path is connected to a stop stimulus. A stop stimulus indicates that the scenario path ends.
- **Segment**: A scenario path has one or more segments. Segments are used to relate value interfaces with each other (e.g. via connection elements) to show that an exchange on one value interface causes an exchange on another value interface.
- **Connection**: Connections are used to relate individual segments. Each fork splits a scenario path into two or more sub-paths, while each join collapses sub-paths into a single path. In AND forks/joins, all incoming and outgoing paths have the same number of occurrences, while in OR forks (joins) the number of occurrences of the incoming (outgoing) path equals the addition of the number of occurrences of the outgoing (incoming) sub-paths. An implosion shows a change in the number of occurrences within a sub-path.

Table 39 below shows the graphical representation of the main e^{3}value concepts.

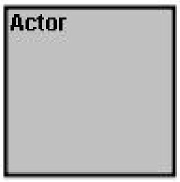
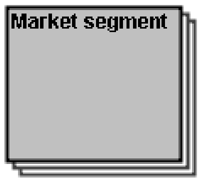
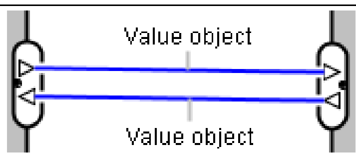
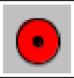
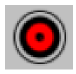
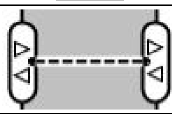
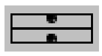
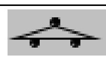
Concept	Graph	Concept	Graph
Actor		Market segment	
Value port		Value interface	
Value object		Value exchange	
Start stimulus		End stimulus	
Segment		Implosion	
AND fork/join		OR fork/join	

Table 39: Graphical representation of main e^{3}value concepts

The goal of the e^3value modelling methodology is to evaluate a business idea, and discover a business scenario, which is feasible for every stakeholder. A business scenario consists of the *business model* and the *scenario path*. The business model is a set of *value objects*, exchanged between *value activities*, performed by different *actors* or *market segments*.

One of the main features of the e^3value methodology is that it is a *conceptual modelling* approach, and that it focuses on the concept of *economic value* as a central conceptual modelling construct. A conceptual modelling approach facilitates the creation of a better shared-understanding and agreement between actors on a service or product to be offered. Besides, this approach allows for the evaluation of a business value model, in order to assess whether the BM is profitable for all the stakeholders involved. The intention is not to give precise calculations about the profit to expect, but rather to build confidence on the commercial viability of the BM, by exploiting what-if scenarios to evaluate the changes in business profitability as a result of changes in economic conditions of its environment.

An actor is perceived by his environment as an economically independent entity. Hence, an actor must be able to be profitable after a reasonable period of time or to increase value for itself. A BM can only succeed if all involved actors regard it as a profitable idea. All involved actors should benefit from the business idea, and the only way to check it is to include all of them in the value model.

The e^3value graphs present the monetary exchanges between the different parties. In each exchange, one actor offers something and gets something else in return, and one of the items exchanged is always money. Only monetary exchanges which happen several times are represented, which means that investments are not included in the graphical models, since the aim of the graph is to obtain the cash-flows for the different actors within defined time-horizons.

The time-horizon for cash-flow calculation depends on market arrangement; if market prices and imbalance prices change every hour, cash-flows are calculated every hour; if prices change more often, cash-flows will be calculated accordingly. Cash-flows are then added up to obtain the annual cash-flow, in order to compare it with the required investment, through traditional methods for valuating investments, such as the Net Present Value (NPV) or the Internal Rate of Return (IRR).

The Net Present Value criterion is an important assessment, which calculates the expected net monetary gain or loss from a project by discounting all expected future cash flows and inflows to the present, using some predetermined minimum desired rate of return. NPV is a very useful tool, because it allows for a comparison of current expenses to undertake a project versus the potential benefits, in this case revenues that the project will yield sometime in the future.

The internal rate of return is the rate of interest at which the present value of expected cash inflows from a project equals the present value of expected cash outflows of the project. IRR, on the other hand, computes a break-even rate of return. It shows the discount rate below which an investment results in a positive NPV (and, hence, the investment could be made) and above which an investment results in a negative NPV (and, thus, the investment should be avoided).

The graphs do not present temporary sequences of exchanges, but the sequence to satisfy one or various needs of one or some actors. For example, in the case of a customer buying a good from a retailer (**Figure 42**), the graph would show that the customer gets the good from the retailer, who gets it from a wholesaler, who gets it from a manufacturer. Of course, the temporary sequence would be that the wholesaler buys the good from the manufacturer, the retailer buys it from the wholesaler and the consumer buys it from the retailer, but that is not important for this analysis.

8.1.2 Business modelling process

The graphical description of the process of building a BM is illustrated in **Figure 43**. BM building includes a number of sequentially executed steps. The result of each step is an input for the following step, and the outcome of the whole process is a BM including a graphical representation and corresponding financial profitability sheets, which facilitate sensitivity analysis of the business case.

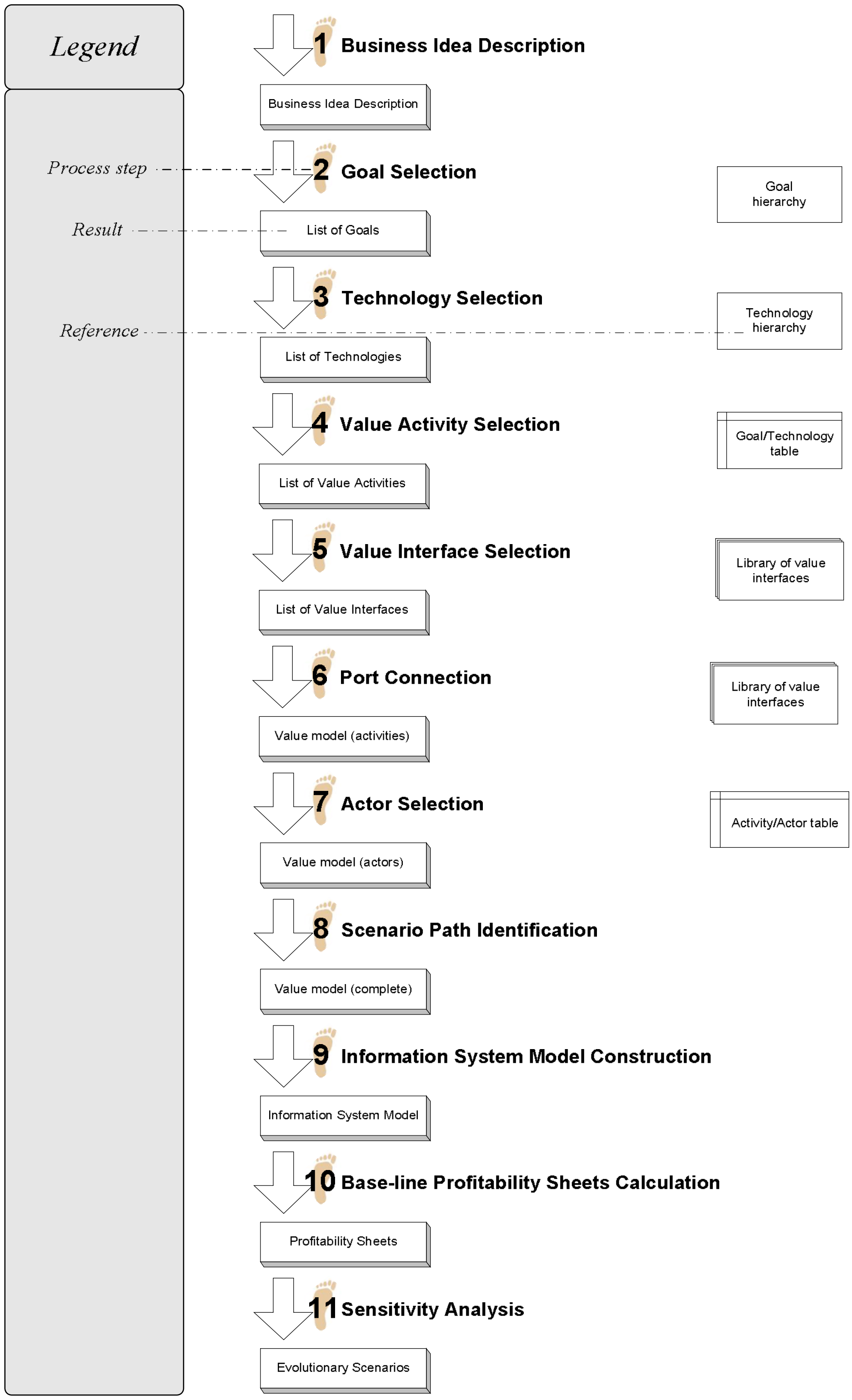


Figure 43: Diagram of the process steps

8.1.2.1 Step 1: Business idea description

Write down a short business case description to express the business idea.

The value model is a representation of the real world. Such a representation cannot include all objects of the real world. Before the modelling process starts, it is important to consider what needs to be modelled and what not.

A business plan can only succeed if all involved actors regard it as a profitable idea. All involved actors should have benefits from the business idea, and the only way to calculate the profitability is to include these actors in the value model. So, the basic rule is to include all involved actors and activities in the BM process.

8.1.2.2 Step 2: Goal selection

The first consideration to be taken when modelling the business is specifying all the goals stakeholders want to satisfy with that business. Some stakeholders' goals may be in conflict with some others' goals, since every actor wants to maximise its profit; but some other stakeholders' goals can also be mutually beneficial. Stakeholders' goals can be strategic (long-term) or operational (short-term).

8.1.2.3 Step 3: Technology selection

Once the goals are identified, the next step is to select an appropriate technology which will deliver the best output of the scenario and achieve both operational and strategic goals.

In Green eMotion, this step will be skipped, since the technology to be used is known in advance.

8.1.2.4 Step 4: Value activity selection

In this step, value activities to be included in the model are selected from the operational goals hierarchy (see [Kartseva 2004]). The operational goal hierarchy is built in a way that every goal has an activity associated with that goal.

8.1.2.5 Step 5: Value interface selection

In this step all value interfaces necessary to model the business case are selected from a library of interfaces (see [Kartseva 2004]), where general and optional interfaces are provided for each activity. For each selected value activity of the previous step, at least the general interfaces must be modelled.

Depending on the scope and the goals to accomplish, the optional interfaces can also be added to the model.

8.1.2.6 Step 6: Ports connection

Before this step the model is unconnected. The value interfaces now must be connected to obtain a connected value model.

8.1.2.7 Step 7: Actor selection

Each activity should be performed by an actor, but this is not a strict one-to-one relation. Some actors perform more than one activity, and in some cases an activity should be divided over two actors.

8.1.2.8 Step 8: Scenario path identification

A scenario path is used to explain cause-effect relationships by travelling over paths through a system. By travelling over the scenario path, you can see which actor starts exchange and what exchanges are done as a result of this start. Scenario paths allow to count the number of value exchanges in a given time period, which is very important to do profitability analysis.

8.1.2.9 Step 9: Information system model construction

Once a correct value model has been constructed, the information system needed to support such a model needs to be addressed. This step is performed only when the expenses to maintain such an information system are substantial; otherwise they will be included as operation & maintenance costs.

In Green eMotion Task 9.3 this step will not be performed, since it is part of WP3.

8.1.2.10 Step 10: Base-line profitability sheets calculation

The evaluation of a BM focuses on the question whether it is feasible from an economic point of view, and whether a scenario is profitable for each actor involved in the value model.

The impact of the BM in the different actors is assessed by creating profitability sheets for each actor involved, where economic value is assigned to objects delivered and received.

8.1.2.11 Step 11: Sensitivity analysis

During the execution of a BM, the profitability of each actor estimated by using profitability sheets, valuation functions, and scenario occurrences and path probabilities, may change substantially.

To estimate the feasibility of a business idea in the future, we use evolutionary scenarios, scenarios that describe events that can possibly take place in future. The analysis of the effects of evolutionary scenarios on profitability may lead to a change in value models, and/or an increase in confidence and a better understanding of the business idea by stakeholders.

8.1.2.12 Step 12: Investment analysis

After a scenario is chosen, a detailed analysis of financial aspects must be made. There are several standard criteria for investment analysis, like the Net Present Value (NPV) and the Internal Rate of Return (IRR), explained at the end of section 8.1.1.

8.2 Other market models and roaming scenarios

In the core of this document, the graphical models for the selected market models, roaming scenarios and contracting alternatives were presented in section 2.5, while the relationships resulting from them can be found in section 3.2

This section presents the graphical models and the relationships for other alternatives not considered in the main body of this deliverable.

8.2.1 BM 1 – Basic charging

8.2.1.1 Independent EVSE Operator

8.2.1.1.1 Roaming of charging service

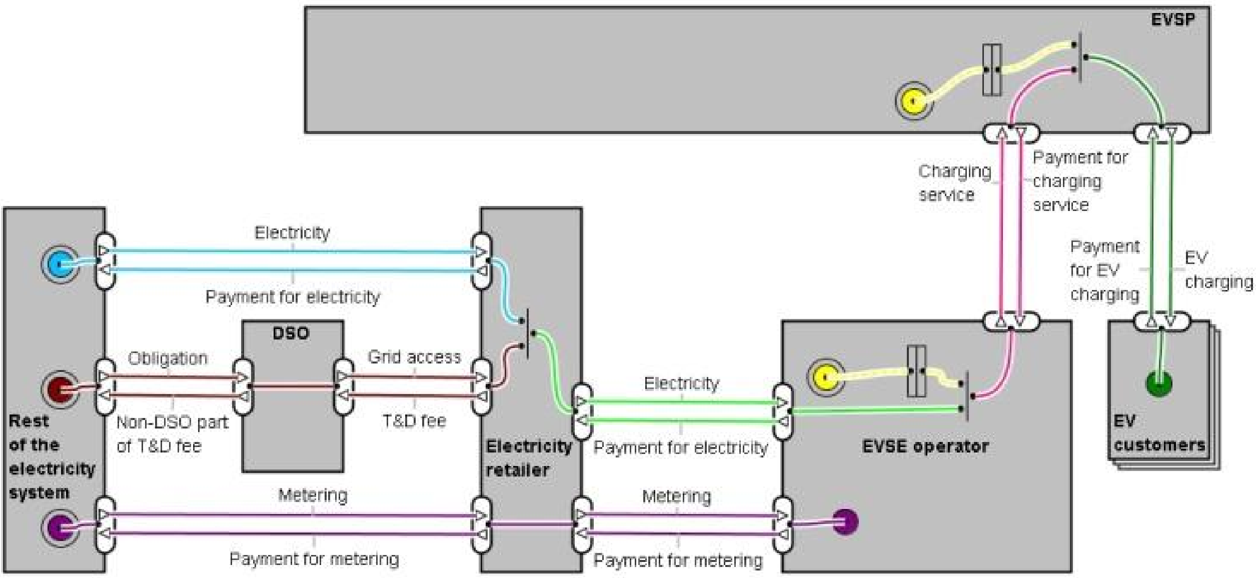


Figure 44: Model for BM 1, Independent EVSE Operator, Roaming of charging service, Bilateral

Pays \ to	EVSP	EVSE Operator	DSO	Electricity retailer	Communication provider
EV customers	EV charging				
EVSP	-	Charging service			Communications
EVSE Operator		-		Electricity / Metering	Communications
Electricity retailer			T&D	-	

Table 40: Relationships in BM 1, Independent EVSE Operator, Roaming of charging service, Bilateral

8.2.1.1.2 Roaming of electricity and service

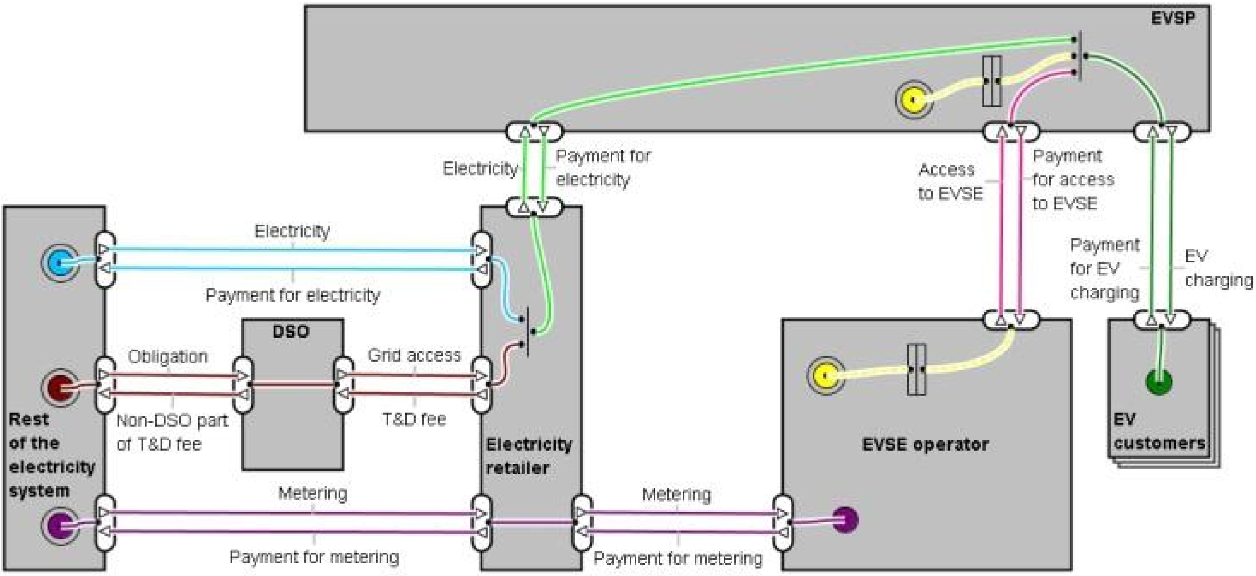


Figure 45: Model for BM 1, Independent EVSE Operator, Roaming of electricity and service, Bilateral

Pays \ to	EVSP	EVSE Operator	DSO	Electricity retailer	Communication provider
EV customers	EV charging				
EVSP	-	Access to EVSE		Electricity	Communications
EVSE Operator		-		Metering	Communications
Electricity retailer			T&D	-	

Table 41: Relationships in BM 1, Independent EVSE Operator, Roaming of electricity and service, Bilateral

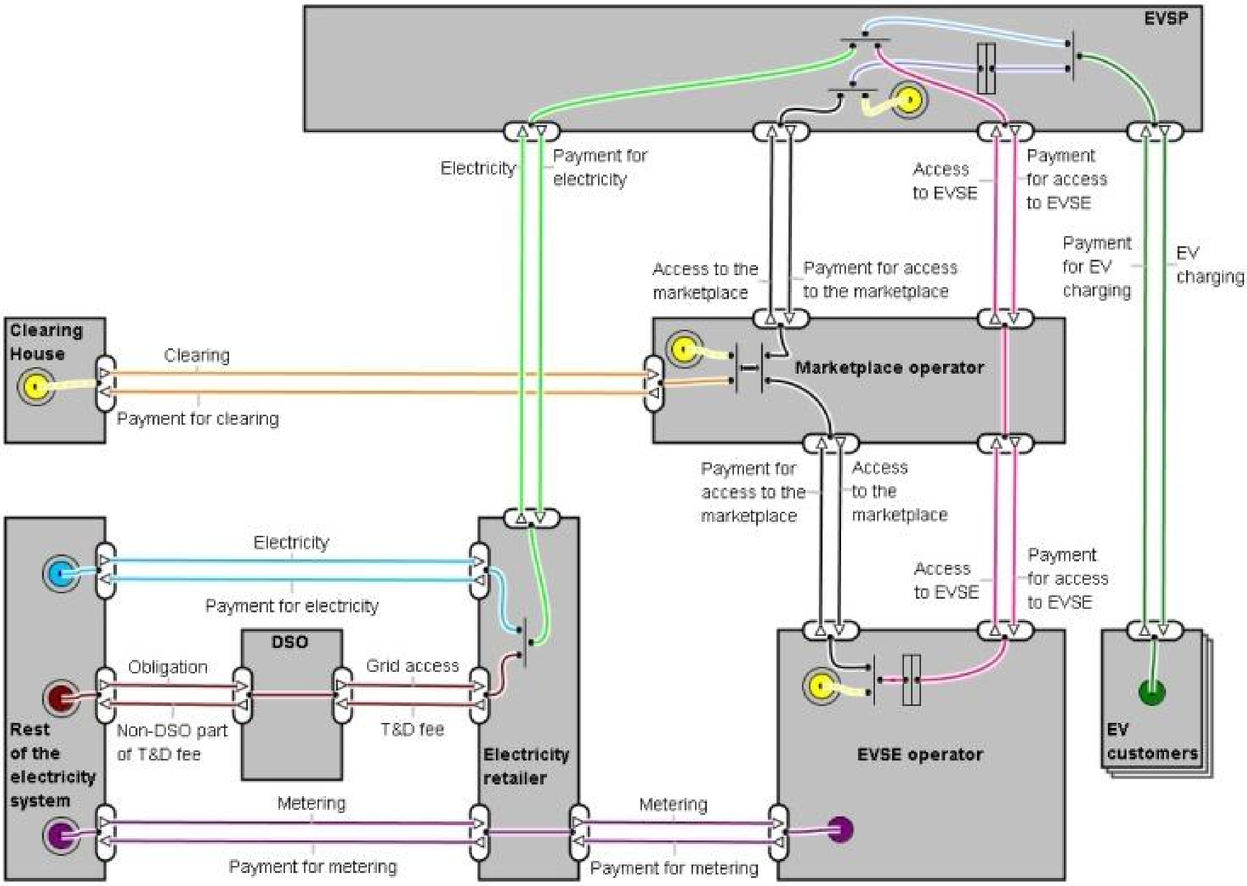


Figure 46: Model for BM 1, Independent EVSE Operator, Roaming of electricity and service, Marketplace

Pays \ to	EVSP	EVSE Operator	DSO	Electricity retailer	CH	Marketplace Operator	Communication provider
EV customers	EV charging						
EVSP	-			Electricity		Access to the marketplace Access to EVSE	Communications
EVSE Operator		-		Metering		Access to the marketplace	Communications
Electricity retailer			T&D	-			
CH					-		Communications
Marketplace Operator		Access to EVSE			Clearing	-	Communications

Table 42: Relationships in BM 1, Independent EVSE Operator, Roaming of electricity and service, Marketplace

According to [D3.4], the goods traded through the marketplace are e-mobility related IT services, not physical goods (including electricity). Therefore, the case in which electricity is traded through the marketplace, which was considered in the work leading to this deliverable, will not be taken into account any more.

8.2.1.2 EVSP as EVSE Operator

The only case in which this market model will be different to the Independent EVSE Operator model is when EV customers charge at an EVSE operated by its EVSP.

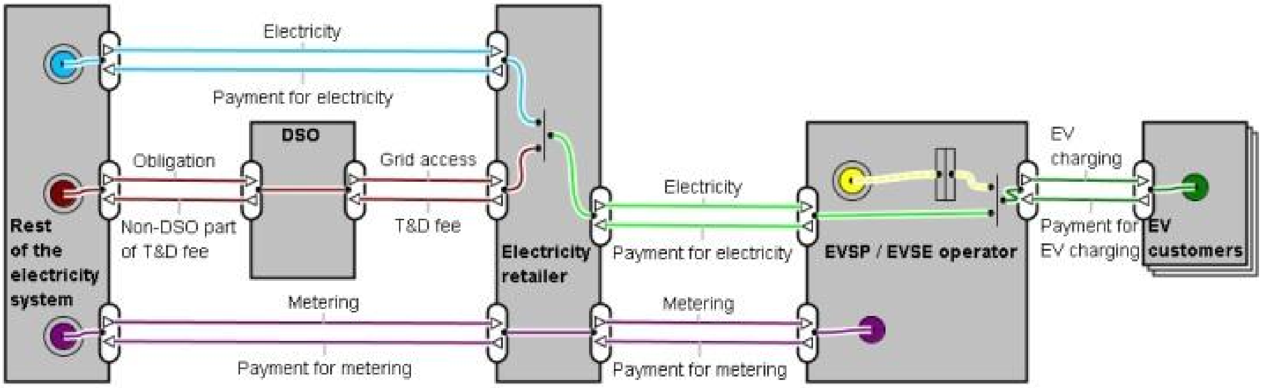


Figure 47: Model for BM 1, EVSP as EVSE Operator, Own EVSE

Pays \ to	EVSP / EVSE Operator	DSO	Electricity retailer	Communication provider
EV customers	EV charging			
EVSP / EVSE Operator	-		Retail electricity Metering	Communications
Electricity retailer		T&D	-	

Table 43: Relationships in BM 1, EVSP as EVSE Operator, Own EVSE

8.2.1.3 DSO as EVSE Operator

In the market model where the DSO is the EVSE Operator, the only available roaming scenario is the roaming of electricity and service, because the DSO, being a regulated actor, cannot select an Electricity retailer and, hence, it will be the EVSP who will select the electricity provider.

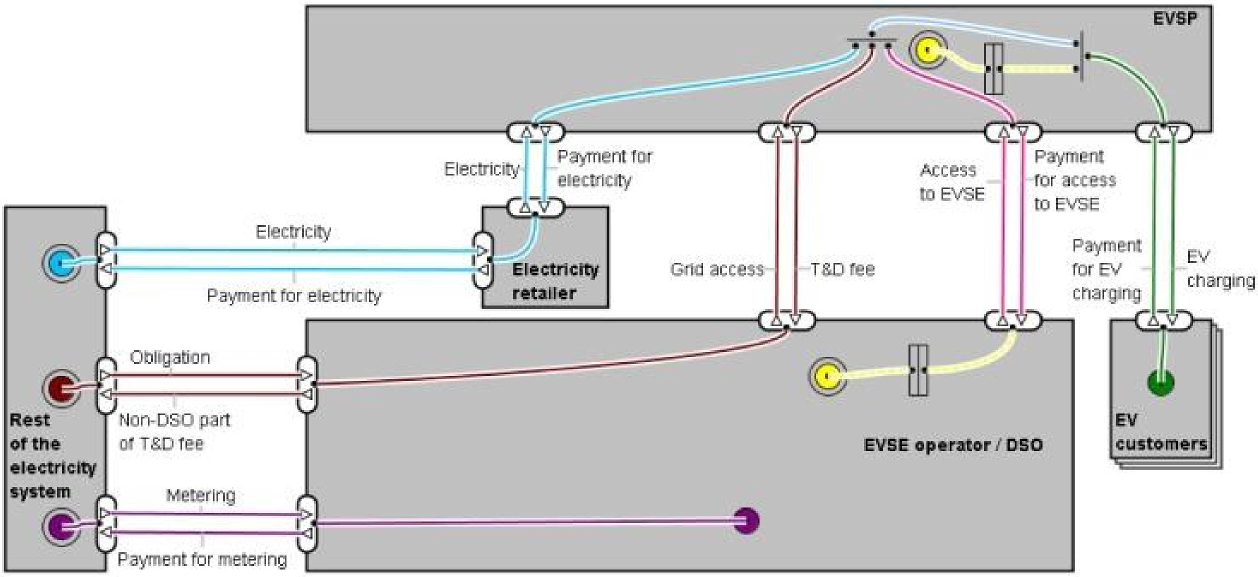


Figure 48: Model for BM 1, DSO as EVSE Operator, Roaming of electricity and service, Bilateral

Pays \ to	EVSP	DSO / EVSE Operator	Electricity retailer	Rest of the electricity system	Communication provider
EV customers	EV charging				
EVSP	-	Access to EVSE T&D	Electricity		Communications
DSO / EVSE Operator		-		Non-DSO part Metering	Communications
Electricity retailer			-	Electricity	

Table 44: Relationships in BM 1, DSO as EVSE Operator, Roaming of electricity and service, Bilateral

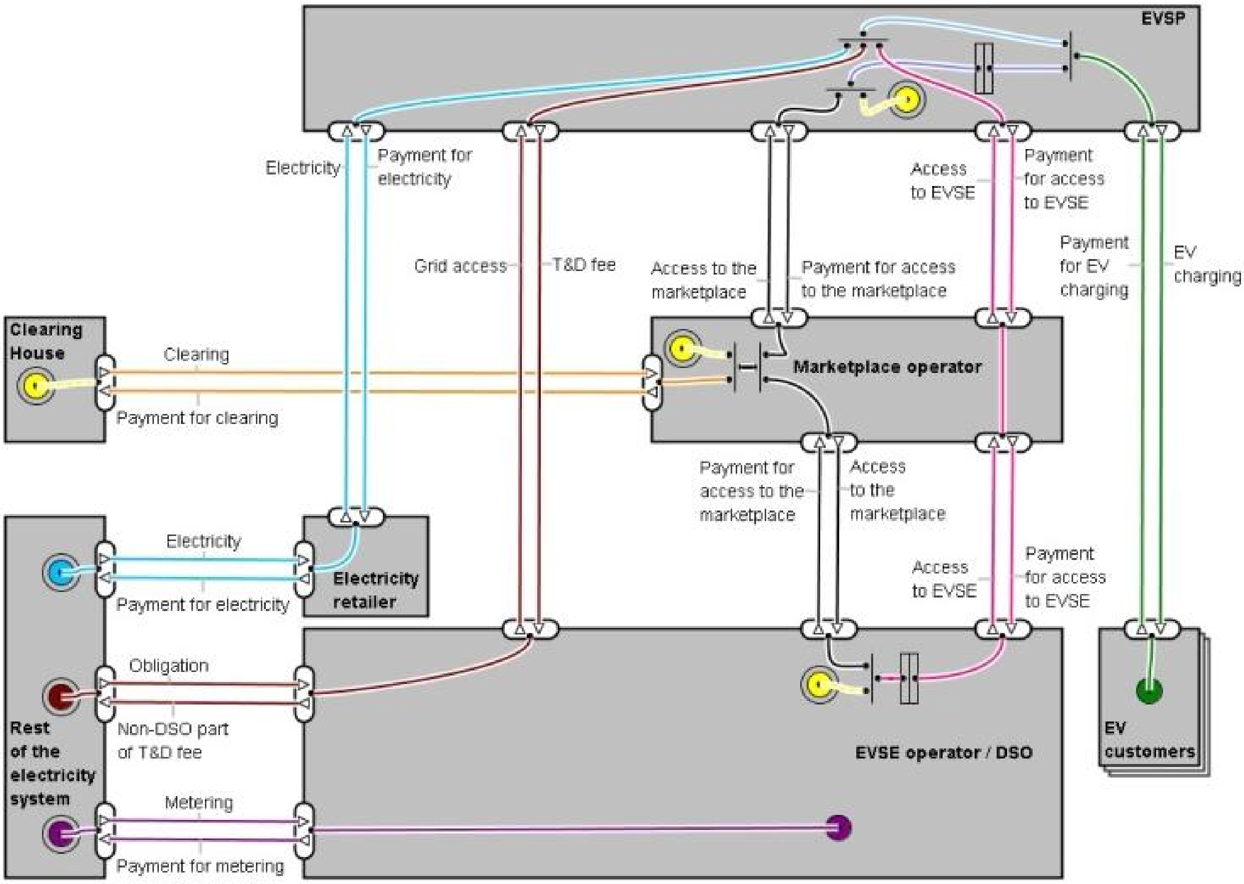


Figure 49: Model for BM 1, DSO as EVSE Operator, Roaming of electricity and service, Marketplace

Pays \ to	EVSP	DSO / EVSE Operator	Electricity retailer	CH	Marketplace Operator	Rest of the electricity system	Communication provider
EV customers	EV charging						
EVSP	-	T&D	Electricity		Access to the marketplace Access to EVSE		Communications
DSO / EVSE Operator		-			Access to the marketplace	Non-DSO part Metering	Communications
Electricity retailer			-			Electricity	
CH				-			Communications
Marketplace Operator		Access to EVSE		Clearing	-		Communications

Table 45: Relationships in BM 1, DSO as EVSE Operator, Roaming of electricity and service, Marketplace

According to [D3.4], the goods traded through the marketplace are e-mobility related IT services, not physical goods (including electricity). Therefore, the case in which electricity is traded through the marketplace, which was considered in the work leading to this deliverable, will not be taken into account any more.

8.2.2 BM 2 – Reservation

8.2.2.1 Independent EVSE Operator

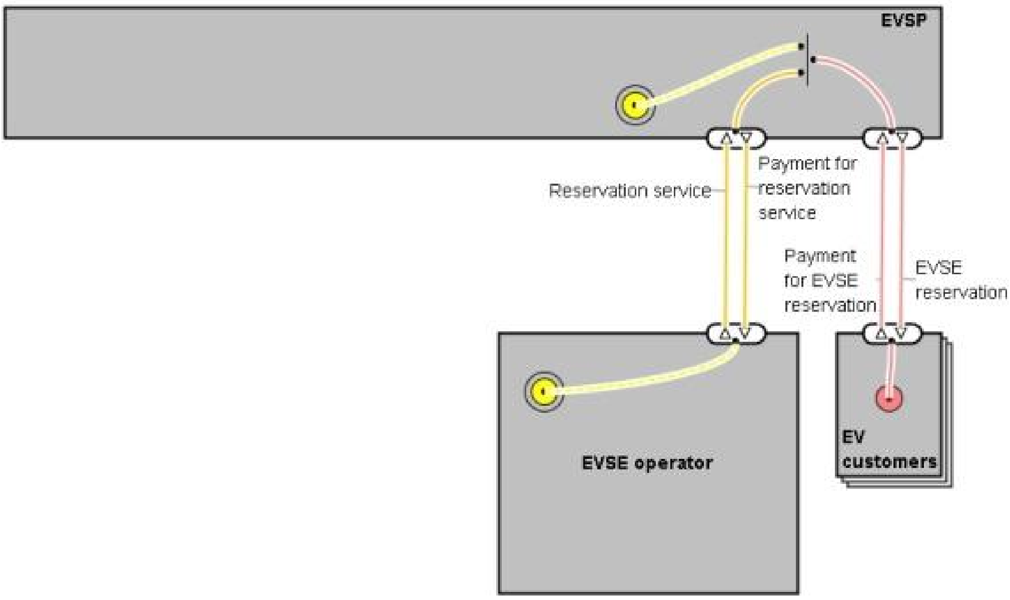


Figure 50: Model for BM 2, Independent EVSE Operator, Bilateral

Pays \ to	EVSP	EVSE Operator	Communication provider
EV customers	EVSE reservation		
EVSP	-	Reservation service	Communications
EVSE Operator		-	Communications

Table 46: Relationships in BM 2, Independent EVSE Operator, Bilateral

8.2.2.2 EVSP as EVSE Operator

As in the case of charging, the only case in which the graphical model and relationships are not the same as in the Independent EVSE Operator market model is the situation in which the market model is the EVSP as EVSE Operator and EV customers reserve an EVSE operated by their EVSP.

In this case, the only relationships are that EV customers pay *EVSE reservation* to the EVSP / EVSE Operator, and that the EVSP / EVSE Operator pays for *Communications*.

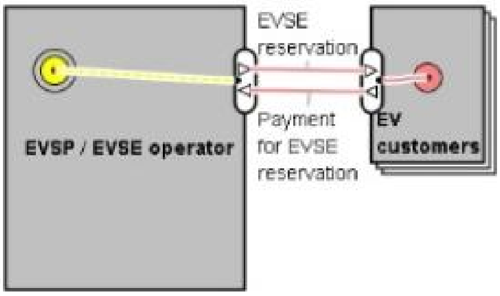


Figure 51: Model for BM 2, EVSP as EVSE Operator, Own EVSE

8.2.2.3 DSO as EVSE Operator

The models for the DSO as EVSE Operator market model are the same as the ones with an independent EVSE Operator.

8.2.3 BM 3 – Congestion management

8.2.3.1 Independent EVSE Operator

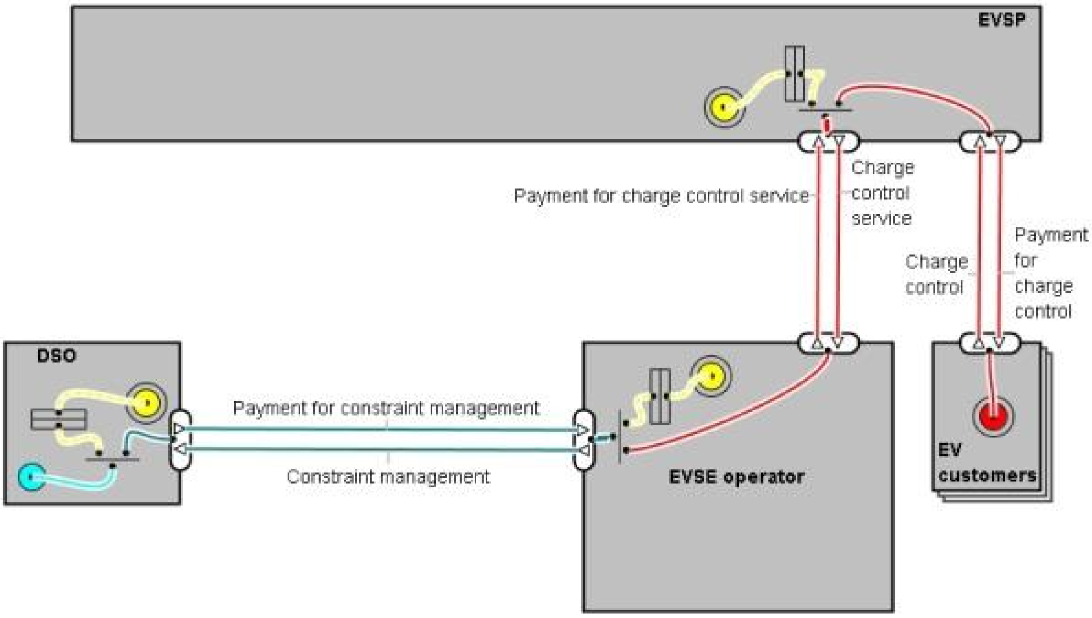


Figure 52: Model for BM 3, Independent EVSE Operator, Bilateral

to / Pays	EV customers	EVSP	EVSE Operator	Comm. provider
EVSP	Charge control	-		Comm.
EVSE Operator		Charge control service	-	Comm.
DSO			Constraint management	Comm.

Table 47: Relationships in BM 3, Independent EVSE Operator, Bilateral

8.2.3.2 EVSP as EVSE Operator

As in the other business models, if the EVSP manages congestion by using the EV customers connected to an EVSE not operated by itself, the model is similar to the independent EVSE Operator case.

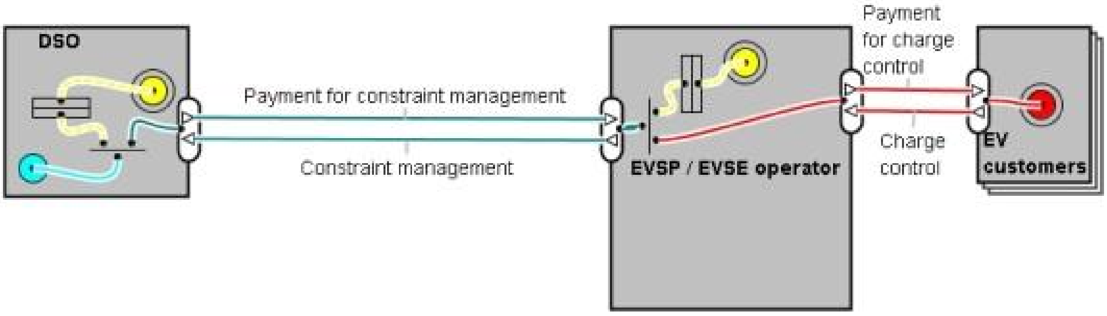


Figure 53: Model for BM 3, EVSP as EVSE Operator, Own EVSE

to / Pays	EV customers	EVSP / EVSE Operator	Communication provider
EVSP / EVSE Operator	Charge control	-	Communications
DSO		Constraint management	

Table 48: Relationships in BM 3, EVSP as EVSE Operator, Own EVSE

8.2.3.3 DSO as EVSE Operator

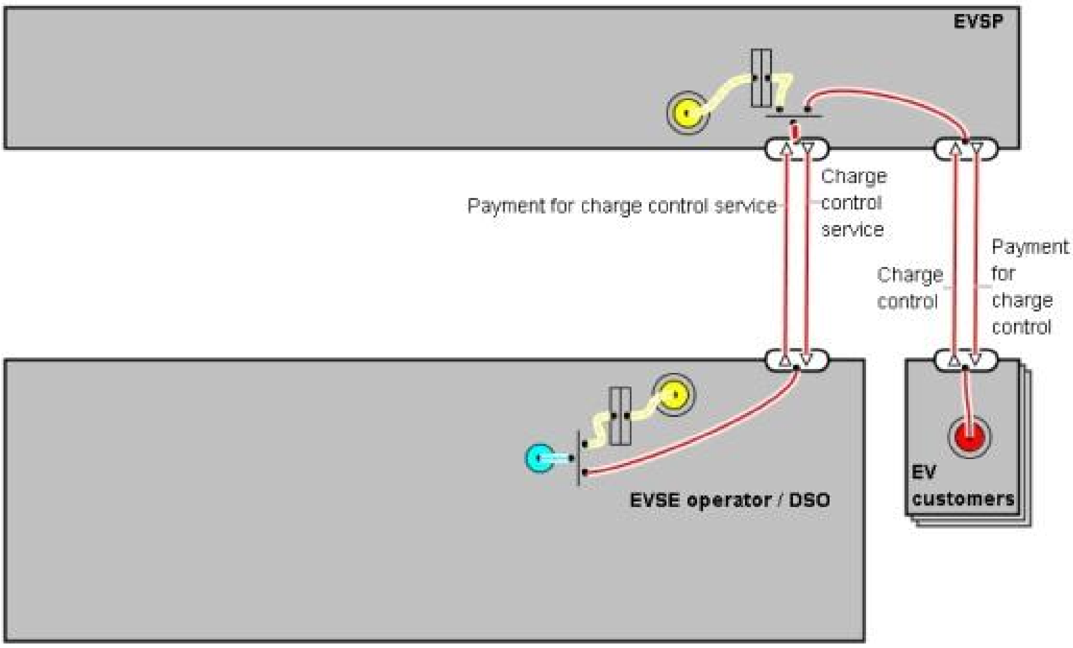


Figure 54: Model for BM 3, DSO as EVSE Operator, Bilateral

to / Pays	EV customers	EVSP	Communication provider
EVSP	Charge control	-	Communications
DSO / EVSE Operator		Charge control service	Communications

Table 49: Relationships in BM 3, DSO as EVSE Operator, Bilateral

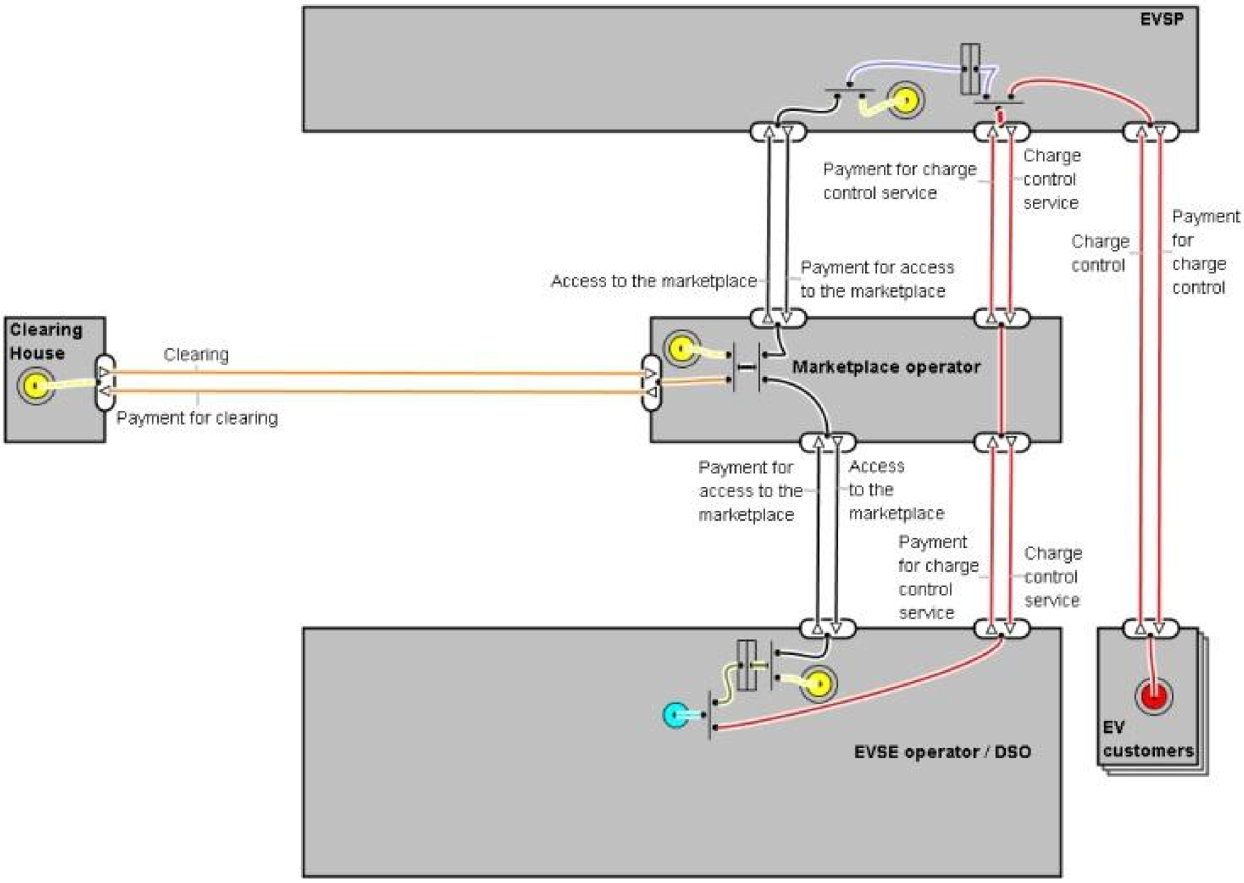


Figure 55: Model for BM 3, DSO as EVSE Operator, Marketplace

to / Pays	EV customers	EVSP	Clearing House	Marketplace Operator	Communication provider
EVSP	Charge control	-		Access to the marketplace	Communications
DSO / EVSE Operator				Access to the marketplace Charge control service	Communications
Clearing House			-		Communications
Marketplace Operator		Charge control service	Clearing	-	Communications

Table 50: Relationships in BM 3, DSO as EVSE Operator, Marketplace

9 Annex II: Performance Indicators and Key performance indicator per each service domain of the Green eMotion Marketplace

9.1 Summary of selected KPI per user level

Actor		PI					
Id	**Name**	**Id**	**Name**	**Description**	**Units**	**Formula**	**Category**
128	EVSP	7	Total cost of roaming services	Roaming costs per charge event	€/charge event	Total cost of roaming services / total number of charge events	Cost
		126	EVSP fixed costs	EVSP staff cost and EBIT	€/year	Yearly EVSP staff cost and EBIT	Cost
		67	% time is park only mode	% of time managed parking site is occupied without use of charge facilities	%	(Amount of time occupied and not charging / total time occupied) *100	Performance
		161	Total trading volume	Total trading volume of services provided through the marketplace	M€	Economic transactions history from all EVSP user accounts	Performance
		155	Response time EVSP - CH	Elapsed time between EVSP operator request to CH response	ms	Response time	Time
		157	Response time EVSP - EVSE	Elapsed time between EVSP operator request to EVSE response	ms	Response time	Time
129	DSO	131	Energy cost	Energy cost from DSO or Retailer	€/kWh	Total cost of energy supply / total energy delivered kWh	Cost
		68	Utilisation time	Amount of time per day when charge point is in use	minutes	Amount of time occupied and in use	Performance
		163	Number of charging reduction calls	Number of charging reduction calls from DSOs using marketplace services	(integer)	Number of charging reduction calls/month	Performance
		36	% not granted charging reduction service requests	Number of not granted charging reduction services as % of all charging reduction services requested	%	(Number of not granted charging reduction service / total charging reduction service requests) *100	QoS
		35	Response time for charging reduction services	Average time it takes to fulfil a charging reduction service request	s/charge event	Total time for identification and authorization processes / total number of congestion events	Time

131	EVSE Operator	143	Average charging energy	Number of charging kWh per year	kWh/year	Total energy from charging reports / year	Performance
132	EVSE Operator	129	EVSE fixed costs	EVSE operator staff cost and EBIT	€/year	Yearly EVSE operator staff cost and EBIT	Cost
		142	EVSE sessions	Number of session per EVSE and per day	(integer)	Number of sessions / EVSE / day	Performance
		144	Charging sessions	Number of charging sessions per year	(integer)	Number of charging sessions / year	Performance
		145	Average energy charged	Average energy per charging session in kWh	kWh	Average energy from charging reports / charging session in kWh	Performance
		146	Average energy price	Energy price per charging session	€/kWh	Price of charging sessions from charging reports / average energy charged in kWh	Performance
		158	Total energy consumed	Total energy consumed through marketplace services	MWh	Energy transactions history from all EVSP user accounts	Performance
		44	% successfully logged events	Successful logging of valid charging data to marketplace as % of total events	%	(Number successes / total number charge events) *100 (per CP?)	QoS
		46	% requests completed	Number of requests for consumption data completed as % of all requests received	%	(Number of requests from EVSP fulfilled / total number records requested) * 100	QoS
		150	Response time EVSE - marketplace	Elapsed time between EVSE operator request to marketplace response	ms	Response time	Time
		154	Response time EVSE - EVSP	Elapsed time between EVSE operator request to EVSP response	ms	Response time	Time
		130	EVSE infrastructure cost	EVSE infrastructure cost including hardware and software assets	€/year	Yearly EVSE infrastructure amortization cost including hardware and software assets	Cost
133	Vehicle Driver	125	Average energy cost	Average cost per charging session	€/charge event	Total cost of charging sessions from charging reports / total number of charge events	Cost
		140	Total EV customers	Total Number of EV customers using the marketplace	(integer)	Total number of EV customers using marketplace as a sum of all clients from service providers	Performance

		141	EV-User sessions	Number of sessions per EV-customer and per day	(integer)	Number of Session / EV-Customer / Day	Performance
		159	Total CO2 emissions	Total CO_2 emissions associated to the energy services provided through the marketplace	Ton.	CO_2 emissions history from all EVSP user accounts	Performance
		160	Total mileage	Total mileage of EV users with marketplace accounts	km	Mileage history from all EVSP user accounts	Performance
		8	% not sent roaming authorization messages	Number of authorization messages not sent due to connectivity issues, backend issues, or EVSP backend / EVSE operator backend has sent wrong data	%	(Number of authorization messages nor sent / total number of roaming authorization requests) *100	QoS
		2	Identification and authorization time	Average time it takes to identify and authenticate a user	s/charge event	Total time for identification and authorization processes / total number of charge events	Time
136	Marketplace Operator	127	Marketplace fixed costs	Marketplace staff cost and EBIT	€/year	Yearly Marketplace staff cost and EBIT	Cost
		132	Marketplace access cost / transaction	Average marketplace access cost per transaction	€/access	Marketplace yearly costs / total number of service requests	Cost
		151	Response time marketplace - CH	Elapsed time between marketplace operator request to CH response	ms	Response time	Time
		153	Response time marketplace - EVSE	Elapsed time between marketplace request to EVSE operator response	ms	Response time	Time
137	Service Provider	82	number of transactions	Number of transactions of a service per day	(integer)	total number of logged transactions per day	Performance
		86	number of new contracts linked to new services	number of new contracts based on new offerings requested through the marketplace	(integer)	number of new contracts for each new service created per month	Performance
		61	% failed search requests	Percentage of search results which cannot be fulfilled	%	(Number of failed search requests / total number of requests received) * 100	QoS
		81	% failed requests	Percentage of requested services which are not fulfilled	%	(Number of failed requests / total number requests received) * 100	QoS

138	Service Requester	79	number new contracts created	Number of new contracts requested and created	(integer)	New contracts per month	Performance
		80	number of transactions	Number of valid service calls created and stored by marketplace	(integer)	Number service transactions per day	QoS
140	CH	128	CH fixed costs	CH staff cost and EBIT	€/year	Yearly CH staff cost and EBIT	Cost
		162	Number of roaming sessions	Number of roaming sessions accounted in the CH	(integer)	Number of roaming sessions / month	Performance
		101	% failed requests	Percentage of unsuccessful remote roaming charging process	%	(Number of unsuccessful remote roaming charging process / total number of attempts) * 100	QoS
		152	Response time CH - marketplace	Elapsed time between CH request to marketplace response	ms	Response time	Time
		156	Response time CH - EVSP	Elapsed time between CH operator request to EVSP response	ms	Response time	Time
143	EV	116	% failed requests	Percentage of failed attempts of EV car sharing user to make a reservation to use an EV	%	(Number of failed requests / total number of requests) * 100	QoS
1355	Business Partner	78	number logins per day	Number of logged sessions per day	(integer)	Number of logged sessions per day	Performance
1367	Marketplace Business Operator	124	Number of new EVSE service created	Number of EVSE registered in the marketplace	(integer)	Number of EVSE new service contract offerings created per month	Performance
1402	Marketplace Technical Operator	88	number of new standard interfaces published over time	Number of new interfaces proposed and published	(integer)	Number of accepted and published standard interfaces per month	Performance

9.2 Core marketplace services use cases

Core / platform services enable the functioning of the Marketplace and facilitate stakeholders to offer and request business services. The core marketplace services domain describes the essential services to run the marketplace itself. It covers mainly the functionality to offer services by service providers and the use of those services by service requesters, referring typically to the terms "Buying" and "Selling".

These terms are processes that can be divided in sub-processes described in the core service chapter. Marketplace services are crucial to effectively realize the business services with the use of Green eMotion marketplace.

9.2.1 1241 UC Call of Service

The Service Requester performs a call of a contracted Service and receives the result. Usually the service call is originated by an end user of the Service Requester.

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
137	Service Provider	81	% failed requests	Percentage of requested services which are not fulfilled due to a technical error	%	(Number of failed requests / total number requests received) * 100	QoS
		82	number of transactions	Number of transactions per service per day	(integer)	Total number of transactions per provided per day	Performance

9.2.2 1374 UC Create Business Partner Account

A new Business Partner is registered at the marketplace. The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
1367	Marketplace Business Operator	89	Number of new accounts created over time	Number of new business partner accounts registered in the marketplace	(integer)	Number of new accounts created per month	Performance

9.2.3 1379 UC Activate Business Partner Account

The account of a Business Partner is activated. For this UC, the following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
1367	Marketplace Business Operator	90	Number of activations over time	Number of business partner accounts activated	(integer)	Number of accounts activated per month	Performance

9.2.4 1380 UC Deactivate Business Partner Account

The account of a Business Partner is inactivated at the marketplace. The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
1367	Marketplace Business Operator	91	Number of deactivations over time	Number of business partner accounts deactivated	(integer)	Number of accounts deactivated per month	Performance

9.2.5 1470 UC Create Service Contract Offering

During the service registration a Service Contract Offering is created from the template of the Service Contract Framework by the Service Provider. For this UC, the following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
1367	Marketplace Business Operator	124	Number of new EVSE service created	Number of EVSE registered in the marketplace	(integer)	Number of EVSE new service contract offerings created per month	Performance

9.2.6 1485 UC Create Service Contract

A Service Contract is created by accepting a Service Contract Offering by the Service Requester. The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
138	Service Requester	79	Number of new contracts created	Number of new contracts requested and created	(integer)	New contracts per month	Performance

9.2.7 1491 UC Create Service Transaction

During a service call of a Service by the Service Requester a Service Transaction Entry is created. The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
138	Service Requester	80	Number of transactions per service	Number of valid service calls created and stored by marketplace per service	(integer)	Number of service transactions per day	QoS

9.2.8 1492 UC Aggregate Service Call Results

The Service Requester performs a call of a Standard Interface based Service for which he has more than one Service Contract with different Service Providers. It results in service calls on all contracted Services. The results of the calls will be aggregated by the marketplace and one response is returned to the Service Requester. For this UC, the following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
137	Service Provider	83	% failed requests	Percentage of requested services which are not fulfilled	%	(Number of failed requests / total number requests received) * 100	QoS

9.2.9 1493 UC Publish Standard Interface

A Service Interface is published as Standard Interface at the marketplace. The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
1402	Marketplace Technical Operator	88	Number of new standard interfaces published over time	Number of new interfaces proposed and published	(integer)	Number of accepted and published standard interfaces per month	Performance

9.2.10 1618 UC Marketplace - Login

A Business Partner authenticates himself against the marketplace. The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
133	Vehicle Driver	141	EV-User sessions	Number of Session / EV-Customer / Day	(integer)	Number of Session / EV-Customer / Day	Performance
132	EVSE Operator	142	EVSE sessions	No of session/EVSE/day	(integer)	No of session/EVSE/day	Performance
132	EVSE Operator	144	Charging sessions	Number of charging sessions/year	(integer)	Number of charging sessions/year	Performance

9.2.11 1629 UC Create Response on Requests for new Services

Potential Service Providers are able to create a response to a Request for new Services, if they are willing to implement and offer a Service that fulfils the request. The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
137	Service Provider	86	Number of new contracts linked to new services offerings	Number of new contracts based on new offerings requested through the marketplace	(integer)	Number of new contracts for each new service created per month	Performance
		85	Number of new service requests answered	Number of new service offerings created from new service requests	(integer)	Number of new services developed per month	Performance

9.2.12 2333 UC Monitor Services

An overview of service PIs is obtained. The following PIs have been defined.

Actor	Actor	PI	PI name	PI description	PI	PI Formula	PI Category

Id	name	Id			result format		
1355	Business Partner	98	% failed requests	Percentage of time that service PIs are not retuned	%	(Number of failed requests / total number of attempted requests) * 100	QoS
133	Vehicle Driver	140	Total EV customers	Total number of EV customers using the marketplace	(integer)	Total number of EV customers using the marketplace as a sum of all clients from service providers	Performance

9.3 General e-mobility use cases

General e-mobility services include all charging and driving related basic and value added services spanning from identification and authorization, through EVSE service monitoring, payment settlements, search and reservation to sophisticated services such as intermodality planning and vehicle telemetry to cloud charging.

The UCs presented in this section are of different scope and level, so, for each of them, a description of scope and level can be found before presenting the selected PIs.

9.3.1 1527 UC Search for EVSE

An EV driver wants to search for an EVSE location in order to increase range of the vehicle. The goal of this UC is to enable the EV driver to select from multiple recharging attributes and filter his search by these.

Scope & Level	EVSE search includes functions (attributes of EVSE) such as: • Geographical information (e.g. actual location of the e-car, planned location for travel / reservation) • Actual availability status (e.g. free, occupied, reserved, out of order, maintenance) • AC charger, DC charger or battery switch station • Type of plug: (e.g. Type 2 / 3 / household) (optional mapping with characters from EV) • Charging power (e.g. 32 ampere) (optional mapping with characters from EV) • Phases: 1-phased or 3 phases • Access: EVSP/EVSE(e.g. RWE, Better Place) membership, open access • Special energy attributes: (e.g. green energy, nuclear energy) • Price: Per kWh, Per hour parking, fixed fee etc. • The search function can be supported from different end-user applications: o Smart Phone (e.g. iPhone, Android) o Internet customer portal o In-Car application (e.g. onboard-unit) The result can be shown on a Geo-Map (e.g. Google-Maps, Bing, Teleatlas) or/and in a text-table. All relevant information (e.g. address, charging plug) has to be included.

The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
133	Vehicle Driver	62	% failed requests	Percentage of search results which cannot be fulfilled	%	(Number of failed requests / total number requests received) * 100	QoS

9.3.2 1592 UC CO2 Reporting

The carbon footprint for an individual EV is calculated for a given period.

Scope & Level	Reduction of carbon emission is a major political goal for electric mobility. This UC will provide information on CO_2 emissions of charging and driving in order to allow a monitoring of fleets. Information as average CO_2 level (per charge) fed into the EV will be combined with the mileage driven into an overall CO_2 impact of an EV (absolute value of CO_2 emitted, g CO_2/km) and the energy efficiency in kWh/km driven.

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
133	Vehicle Driver	159	Total CO_2 emissions	Total CO_2 emissions associated to the energy services provided through the marketplace	Ton.	CO_2 emissions history from all EVSP user accounts	Performance
133	Vehicle Driver	160	Total mileage	Total mileage of EV users with marketplace accounts	km	Mileage history from all EVSP user accounts	Performance

9.3.3 1528 UC Reservation of EVSE

EV driver is able to reserve a selected EVSE, through available interfaces for a desired period of time, e.g. driver wants to reserve a charging point in advance in order to charge the EV. This enables extended-range journeys with increased confidence.

Scope & Level	Value added service The search function can be supported from different End user-Customer applications: • The result can be shown on a Geo-Map (e.g. Google-Maps, Bing, Teleatlas) or/and in a text-table. All relevant information (e.g. address, plug type etc.) has to be included. • To reserve an EVSE the EV driver has to choose a suitable EVSE and then reserve the relevant time frame. • The reservation function can be with costs from the EVSP / EVSE for the EV driver. • To confirm the reservation of the EVSE, the EV driver receives a confirmation message per email, SMS or similar. The reservation function can be supported from different end user/customer devices: • Smart Phone (e.g. iPhone, Android) • Internet-Customer-Portal • In-Car application (e.g. onboard-unit)

The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
133	Vehicle Driver	63	% failed requests	Percentage of requests which cannot be fulfilled	%	(Number of failed requests / total number requests received) * 100	QoS

9.3.4 1574 UC Third party information

An EV driver wants to search for an EVSE (charge point) in order to charge the EV or for short time parking. The EV driver uses his end user customer application to connect to the city pilot service of his EVSP. This UC enables the search for a charge point to combine personal preferences of end user and information from third party providers.

Scope & Level	Value added service. The city pilot service within the EVSP backend uses information from 3rd party providers to adapt the search results regarding to the personal preferences of the EV driver. Possible preferences are e.g.: • Points of Interest (POI) • Favourite chains • Special sales • Special events (concert, movie) Preferences can be combined with options to fine tune the search result. Possible options are e.g.: • Time of the day • Season • Traffic news • Timetable of public traffic • Weather forecast This UC is linked to the search for CP (UC 1527), which is embedded in the before charging UC (UC 1510).

The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
133	Vehicle Driver	64	Request response time	Time taken to return requested search results	ms	Average response time per user request	Time

9.3.5 1502 UC EV Identification, Authentication and Authorization

The goal of this UC is to enable the EVSE operator to authorize the EV driver to use EVSE services (charge or replace battery, etc.) and determine the payment details.

Scope & Level	Basic end-user services. This UC covers identification of contract belonging to a user (own customer or roamer) at a charge spot or battery switch station, and his authentication and authorization to execute the process of charging or battery switching). The UC describes the interaction between EV/ EV driver, EVSP, EVSE operator and optionally the CH (when roaming).

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
131	EVSE	92	% failed requests	Percentage of requested services which are not fulfilled	%	(Number of failed requests / total number requests received) * 100	QoS
1539	Electric Vehicle Communication Controller (EVCC)	94	Request response time	Time taken for request to be acknowledged and approved	ms	Average system time for request completion	Time
128	EVSP	96	% failed requests	Percentage of requested services which are not fulfilled	%	(Number of failed requests / total number requests received) * 100	QoS
1541	Supply Equipment Communication Controller (SECC)	93	Request response time	Time taken for request to be acknowledged and approved	ms	Average system time for request completion	Time
133	Vehicle Driver	95	Charge request response time	Time taken from RFID swipe to approval and charge delivery	s	Average time to start charge process	Time
132	EVSE Operator	150	Response time EVSE - marketplace	Elapsed time between EVSE operator request to marketplace response	ms	Response time	Time
136	Marketplace Operator	151	Response time marketplace - CH	Elapsed time between marketplace operator request to CH response	ms	Response time	Time
140	CH	152	Response time CH - marketplace	Elapsed time between CH request to marketplace response	ms	Response time	Time
136	Marketplace Operator	153	Response time marketplace - EVSE	Elapsed time between marketplace request to EVSE operator response	ms	Response time	Time
132	EVSE Operator	154	Response time EVSE - EVSP	Elapsed time between EVSE operator request to EVSP response	ms	Response time	Time
128	EVSP	155	Response time EVSP - CH	Elapsed time between EVSP operator request to CH response	ms	Response time	Time
140	CH	156	Response time CH - EVSP	Elapsed time between CH operator request to EVSP response	ms	Response time	Time

128	EVSP	157	Response time EVSP - EVSE	Elapsed time between EVSP operator request to EVSE response	ms	Response time	Time

9.3.6 1518 UC During charging

The primary goal of this UC is to acquire a sufficient EV battery state of charge. Secondary goals may include use of services related to charging or battery switching, such as control of charge, priority charge, cost optimized charge, communication (progress report), etc.

Scope & Level	End-user services. This UC covers the enhanced connect - charge - disconnect cycle (FTR1358) with additional services. The UC describes interaction between EV driver, EVSE Backend and optional 3rd parties (Energy trader, DSO, public sector). **Note** that Identification, Authentication and Authorization is a separate UC (UC 1502) but parties may choose to implement UC 1502 between the Before and During charging UCs.

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
1406	EVSE Operator Backend	1	Cost of communications during charging	Marginal cost of communications for EVSE service provision including: real-time user notification regarding charging status; charge data collection, transfer and uploading between EVSE and other parties (EVSP, CH, etc.).	€/charge event	Total cost of communications/ total number of charge events	Cost
133	Vehicle Driver	4	% interrupted charging processes	Number of interrupted charging processes as % of total	%	(Number of interrupted charging processes / total number of charge events) *100	QoS
		3	% not granted access requests	Number of not granted access requests as % of all access requests received	%	(Number of not granted access / total access requests received) *100	QoS
		2	Identification and authorization time	Average time it takes to identify and authenticate a user	s/charge event	Total time for identification and authorization processes / total number of charge events	Time

9.3.7 1519 UC After charging

The primary goal of this UC is that the EVSE Operator documents charging data. Consequently, the EVSE operator distributes relevant information to the EV driver and third parties (receive charging report). By this UC, the user is enabled to use consumption monitoring services or "after-charging services" (view bills including kWh/km and roaming services consumed, CO2-footprint etc.) through a compatible interface with a service provider (telematics, app, website, email, phone call to customer services centre or similar communication link.

Scope & Level	Basic end-user services. This UC covers all EVSP or marketplace routed services triggered by the action of unplugging the car from the charging (or completing the battery switch).

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
1406	EVSE Operator Backend	6	% incorrect after charging service	Number of after charging services requests where the user is offered services based on incorrect or inaccurate information	%	(Number of incorrect after charging services / total number of after charging services requests) *100	QoS
133	Vehicle Driver	5	Cost of after charging services	Monthly cost to access and consume consumption monitoring services	€/month	Total cost of after charging services / months of service	Cost
133	Vehicle Driver	125	Average energy cost	Average cost per charging session	€/charge event	Total cost of charging sessions from charging reports / total number of charge events	Cost
131	EVSE Operator	143	Average charging energy	Number of charging kWh/year	(integer)	Total energy charged from charging reports / year	Performance
132	EVSE Operator	145	Average energy charged	Average energy per charging session	kWh	Average energy from charging reports / charging session in kWh	Performance
		146	Average energy price	Energy price in charging session	€/kWh	Price of charging sessions from charging reports / average energy charged in kWh	Performance
129	DSO	131	Energy cost	Energy cost from DSO or Retailer	€/kWh	Total cost of energy supply / total energy delivered kWh	Cost

9.3.8 1510 UC Before charging

An EV driver can select a satisfactory EVSE location and find his way to it.

EV driver may use services such as route planning, identification of available EVSE, charging location reservation, etc., and access these services through a compatible on-board interface (telematics, mobile app, phone call to a customer service centre or similar) with a service provider.

Scope & Level	Basic end-user services. This UC covers the phase from identifying the need for charged EV batteries, through making the charging decision, planning the route to the arrival at the selected or reserved charging location. The UC describes interaction between an EV driver and a device that is connected to a service provider. The EVSP might provide its services to the EV driver based on the interaction with other service providers directly or via the Marketplace

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
1406	EVSE Operator Backend	61	% failed requests	Percentage of search results which cannot be fulfilled	%	(Number of failed requests / total number requests received) * 100	QoS
133	Vehicle Driver	61	% failed requests	Percentage of search results which cannot be fulfilled	%	(Number of failed requests / total number requests received) * 100	QoS

9.3.9 1558 UC Update Charging Details

The detailed charging information is transferred to the marketplace database (value added service). The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
132	ACT EVSE Operator	44	% successfully logged events	Successful logging of valid charging data to marketplace as % of total events	%	(Number successes / total number charge events) * 100 (per CP?)	QoS

9.3.10 1561 UC Calculate CO2 Emission

The goal is to calculate a list of CO_2 indexes of an EV for a requested period of time. This way, the CO_2 emissions of an energy supplier can be calculated (value added service). The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
132	EVSE Operator	45	% requests completed	Number of requests for CO_2 emissions successfully calculated and logged as % of total	%	(Number logged records / total number of charge events) *100	QoS

9.3.11 1562 UC Report Electricity Consumption

The charging service of a requested vehicle is reported with a CDR and made available to the EVSP through the marketplace or transferred directly from the EVSE operator.

Scope & Level	Value added service. It shows the electricity consumption of a vehicle. This UC enables EVSE operator to report an EVSP of current and historical charging service consumed (e.g. electricity consumption) by a given EV driver

The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
132	EVSE Operator	46	% requests completed	Number of requests for consumption data completed as % of all requests received	%	(Number of requests from EVSP fulfilled / total number records requested)*100	QoS

9.3.12 1564 UC Show Current EV Position

The last / current position of an EV is evaluated and displayed for EV tracking (basic end user service). The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
143	EV (on board equipment)	57	% time with full service	Percentage of time that mobile data and GPS connections are available	%	(Time with good connections/total time frame analysed)*100	QoS
137	Service Provider	58	% valid positions reported	Number of valid positions reported and logged as % of total positions returned	%	(Number of valid positions successfully logged / total number reported) * 100	QoS

9.3.13 1567 UC Call for Roadside Assistance

When the driver is actively asking for roadside assistance, this UC initiates call for roadside assistance from an EV or a mobile device through an EVSP directly or through a marketplace (basic end user service). The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
143	EV (on board equipment)	59	Time to acknowledgement	Time taken to make call for roadside assistance and receive acknowledgement from marketplace	minutes / request	Average time taken to make call and receive acknowledgement from marketplace	Time

9.3.14 1568 UC Show EV Position History

The list of positions of an EV is displayed e.g. in a map (basic end user service). The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
137	Service Provider	60	% failed requests	Percentage of requests to display EV position history which cannot be fulfilled	%	(Number of failed requests / total number requests received) * 100	QoS

9.3.15 1575 UC Crash Notification

In this UC, an automatic or manual notification of a crash is sent to the marketplace (basic end user service). The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
1595	Emergency Services Centre	54	Time to call back	Length of time taken from receipt of EV crash notification to initiate call back to driver	minutes/request	Average time taken to call driver after receipt of automated notification	Time
		53	Time to resolution of incident	Length of time taken from receipt of EV crash notification to resolution or rescue dispatch	minutes/request	Average time taken to receive automated notification and respond	Time

9.3.16 1569 UC Transmit Notification

A notification is sent from the marketplace to the on-board unit of the requested EV or the other way round. The message is transmitted to the driver of the vehicle if recommended and can be acknowledged. Notifications to the marketplace are acknowledged automatically.

Scope & Level	Basic end user service. Scenario O2c. Send a notification between the marketplace and the EV.

The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
137	Service Provider	65	% requests completed	% of notifications which are acknowledged	%	(Number of acknowledged notifications/total number of notifications sent)*100	QoS

9.3.17 1576 UC Set Geofence

The goal is to set the geofence for an EV (basic end user service). The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
137	Service Provider	66	% failed requests	Percentage of search results which cannot be fulfilled	%	(Number of failed requests / total number requests received) * 100	QoS

9.3.18 1529 UC Charging Location Management

A charging location is a site with charging points usually run by EVSE Operators. Every charging location needs a management component that enables site-monitoring, controlling and communication with the marketplace. This component also makes customer authentication requests to the CH. The goal of Charging Location Management UC is to control and monitor charge sessions / processes, as well as to transfer values and status messages from the CP (EVSE) to third parties.

Scope & Level	Basic end user service. The basis for the UC is that the Charging spot master data (e.g. CP-ID, address, technical data) are registered within the Charging Location Management. The EVSE Operator will monitor the charging session with the following functionality: • actual status (e.g. free, charging, maintenance) of the EVSE • actual consumption of the EVSE / Session • actual status of charging spot environment (e.g. FI- / LS-switch, panel) • Alarms from the Charging Spot The EVSE Operator will control the charging spots with the following functionality: • Reboot of Charging Spot • Switching (e.g. FI / LS) • Start- / End of Charging Session • SW-Update (per remote connection) Configuration management/monitoring can be done by a context menu (tree, map and list). The Charging Location Management application needs interfaces to the following applications to support the authentication of EV end-user and search/reservation of EVSE: • EVSE (bidirectional) • CH (bidirectional) • EV end-user customer portal For the reporting of the charging sessions, the EVSE operator can analyse the actual and historical data within the Charging Location Management application.

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
129	DSO	50	Charge point supply stability	Length of time for which supply to EVSE is available without interruption (site up time)	days or %	Time at proper operating conditions since last fault / outage (as a %?)	Time
		68	utilisation time	Amount of time per day when charge point is in use	min	Amount of time occupied and in use	Performance
131	EVSE	55	Time without fault (site up time)	Time that the EVSE has full communications and supply needed to satisfy location management feature	days	Time at proper operating conditions since last fault/outage	Time

9.3.19 1563 UC Parking Space Monitoring

A service requester uses the Parking Space Monitoring service to monitor the usage of the parking spaces at EVSEs.

Scope & Level	Value added service. Parking space monitoring The service requester will be enabled to monitor the: • usage of CPs (number of CPs connected to any EV) • usage of parking spaces (CPs physically occupied by vehicles, but not charging)

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
131	EVSE	56	% errors logged	Number of errors logged by EVSE when attempting to send parking data to the marketplace	%	(Number of failed requests / total number requests received) * 100	QoS
1406	EVSE Operator Backend	51	% of errors logged	Number of CP locations equipped with parking sensors which are not returning data	%	(Number of CP errors logged by backend system / total number of events) * 100	QoS
128	EVSP	51	% of errors logged	Number of CP locations equipped with parking sensors which are not returning data	%	(Number of CP errors logged by backend system / total number of events) * 100	QoS
135	Public Sector	51	% of errors logged	Number of CP locations equipped with parking sensors which are not returning data	%	(Number of CP errors logged by backend system / total number of events) * 100	QoS

9.3.20 1557 UC Parking Space Management

The EV is allowed by the EVSE backend to park at desired/selected parking spaces, regardless of its need to charge.

Scope & Level	Value added service. Parking space management. An EV driver needs a parking space only. Therefore the EV driver shall be able to use a CP as parking lot without charging the EV. This UC extends the UC Charging Location Management (1529).

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
128	EVSP	67	% time is park only mode	% of time managed parking site is occupied without use of charge facilities	%	(Amount of time occupied and not charging / total time occupied) *100	Performance
133	Vehicle Driver	52	Request response time	Length of time taken to respond to user request for “Park Only” mode	ms/request	Average response time per user request	Time

9.3.21 1548 UC Access Car Information

Users should get access to car information items e.g. state of charge, est. range, etc. (value added service). Fleet users, e.g. in “innovative car on demand pools”, may have different requirements regarding space and trunk capacity or range for single trips. Hence a vehicle reservation out of such a fleet should allow a search based on these criteria.

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
1594	Fleet Manager	69	search time	Time taken to return requested search results	ms	Average response time per user request	Time
136	Marketplace Operator	70	% failed requests	Percentage of search results which cannot be fulfilled	%	(Number of failed requests / total number requests received) * 100	QoS
137	Service Provider	70	% failed requests	Percentage of search results which cannot be fulfilled	%	(Number of failed requests / total number requests received) * 100	QoS
133	Vehicle Driver	69	search time	Time taken to return requested search results	ms	Average response time per user request	Time

9.3.22 1520 UC Users can book pool-cars online

The user wants to have a pool-car in a specific time frame for a specific trip (value added service).

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
1594	Fleet Manager	71	% requests completed	Percentage of requests for online booking successfully completed	%	(Number of successful requests / total number requests received) * 100	QoS
133	Vehicle Driver	71	% requests completed	Percentage of requests for online booking successfully completed	%	(Number of successful requests / total number requests received) * 100	QoS

9.3.23 1525 UC User wants to travel and has specific requirements

The user wants to travel from A to B, using the fastest, cheapest and most efficient means of transport. He/she can book his planned travel online (value added service). The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
137	Service Provider	72	% requests completed	Percentage of requests for travel that are successfully fulfilled	%	(Number of successful requests / total number requests received) * 100	QoS

133	Vehicle Driver	72	% requests completed	Percentage of requests for travel that are successfully fulfilled	%	(Number of successful requests / total number requests received) * 100	QoS

9.3.24 1522 UC Assign car to scenario

Cars can be assigned to various scenarios which affect availability of the car (value added service). A scenario can, for example, be "executive use only" which restricts booking to executives only or "maintenance" which would indicate that the car is being maintained or in need of maintenance and cannot be booked at all. The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
1594	Fleet Manager	73	% requests completed	Percentage of requested assignments which are completed	%	(Number of successful requests / total number requests received) * 100	QoS

9.3.25 1521 UC Status for cars can be maintained by Fleet Manager

The fleet manager wants to maintain the status of a car (value added service). The fleet manager can set status information for each car to track damages, failures, need for repair / maintenance as well as work that has been done so far (parts replaced, maintenance- and service-work). The system notifies the fleet manager when service works are necessary. The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
132	EVSE Operator	47	% logged errors per charge point	Number of times a fleet vehicle status cannot be successfully queried/set as %	%	(Number logged errors / total number events)*100	QoS

9.3.26 1523 UC Fleet manager tracks pool-car

The goal is the tracking of cars (value added service): the system submits the whereabouts of each car, either by GPS/GSM or when plugged to EVSE (identification through Vehicle Identification Number / location through EVSE location). The fleet manager is able to track the cars down.

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
132	EVSE Operator	48	% locations logged	Number of vehicle locations successfully logged through vehicle ID	%	(Number of events successfully logged / total number of events) *100	QoS
1594	Fleet Manager	74	% failed requests	Percentage of tracking search results which cannot be fulfilled	%	(Number of failed requests / total number requests received) * 100	QoS

9.3.27 1524 UC Fleet manager monitors energy consumption of pool-cars

The goal is the monitoring of energy consumption for single cars or the whole fleet (value added service).

The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
132	EVSE Operator	49	% consumption events recorded	Successful logging of energy consumption data to marketplace as % of total events	%	(Number of successfully logged events / number of charge events) * 100	QoS

9.3.28 2248 UC Search for intermodal transport

It is an application that enables EV Driver to search for EVSE including the connection to intermodal transportation and further routing to final destination (value added service).

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
133	Vehicle Driver	99	% failed requests	Percentage of search results which cannot be fulfilled	%	(Number of failed requests / total number requests) * 100	QoS
133	Vehicle Driver	100	search time	Time taken to return requested search results	ms/request	Average response time per user request	Time

9.3.29 2249 UC Remote Authentication / Push Authorization

The goal is the start of a cleared roaming charging process (clearing service). The EV driver activates charging using an authentication means (e.g. Smartphone App or Hotline) of his home provider.

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
131	EVSE Operator Backend	101	% failed requests	Percentage of unsuccessful remote roaming charging process	%	(Number of unsuccessful remote roaming charging process / total number of attempts) * 100	QoS
128	EVSP Backend	101	% failed requests	Percentage of unsuccessful remote roaming charging process	%	(Number of unsuccessful remote roaming charging process / total number of attempts) * 100	QoS
133	Vehicle Driver	101	% failed requests	Percentage of unsuccessful remote roaming charging process	%	(Number of unsuccessful remote roaming charging process / total number of attempts) * 100	QoS

9.3.30 2252 UC Select and reserve intermodal transport

EV driver is able to reserve a charge pole and connecting transportation through the Intermodality application (value added service). The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
133	Vehicle Driver	102	% failed requests	Percentage of time that EV driver cannot select and reserve intermodal transport	%	(No of unsuccessful requests / total no of requests) * 100	QoS
133	Vehicle Driver	103	Request response time	Average time taken to select and reserve intermodal transport	ms/request	Average response time per user request	Time

9.3.31 2253 UC Navigate to destination of Intermodal transport

EV driver is offered navigation assistance to EVSE and connecting transportation through the Intermodality application (value added service).

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
133	Vehicle Driver	104	% failed requests	Percentage of time that navigation assistance to the destination of intermodal transport is not available	%	(Number of unsuccessful requests / total number requests) * 100	QoS
133	Vehicle Driver	105	Request response time	Average time it takes for navigation assistance to be returned	ms/request	Average response time per user request	Time

9.3.32 2255 UC Open access

The goal is to provide charging for a customer regardless of EVSP or roaming contracts normally granting access to a specific EVSE (value added service). Authorization, access and payment are processed on the spot – this UC is referred to as “open access”.

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
1406	EVSE Backend	106	% failed requests	Percentage of time that open access charging cannot be authorised	%	(Number of times open access charging cannot be authorised / total number requests received) * 100	QoS
133	Vehicle Driver	106	% failed requests	Percentage of time that open access charging cannot be authorised	%	(Number of times open access charging cannot be authorised / total number requests received) * 100	QoS

131	EVSE	106	% failed requests	Percentage of time that open access charging cannot be authorised	%	(Number of times open access charging cannot be authorised / total number requests received) * 100	QoS
1579	Third Party Service Provider	106	% failed requests	Percentage of time that open access charging cannot be authorised	%	(Number of times open access charging cannot be authorised / total number requests received) * 100	QoS

9.3.33 2257 UC Driver portal transactions and energy information

A Web or mobile application enables EV Driver visualize the transaction history of his EVSP account and RFID cards and respective balances (value added service, realising 2258 FTR Driver portal). The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
133	Vehicle Driver	107	% failed requests	Percentage of requests to display transaction history which cannot be fulfilled	%	(Number of failed requests / total number requests) * 100	QoS
132	EVSE Operator	158	Total energy consumed	Total energy consumed through marketplace services	MWh	Energy transactions history from all EVSP user accounts	Performance
128	EVSP	161	Total trading volume	Total trading volume of services provided through the marketplace	M€	Economic transactions history from all EVSP user accounts	Performance

9.3.34 2261 UC EVSE network portal homepage view charge poles

Homepage of web portal to enable EVSE network operator visualize EVSE connection points on a GIS interface such as Google maps and view selected basic parameters of the EVSE (value added service, realising 2259 FTR EVSE network portal). The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
132	EVSE Operator	108	% failed requests	Percentage of requests to display EVSE locations and basic parameters data which cannot be fulfilled	%	(Number of failed requests / total number requests) * 100	QoS

9.3.35 2264 UC EVSE network portal energy flows

A section of web portal enables EVSE network operator to visualize EVSE connection points and obtain information about the EVSE viewed at multiple levels and related to energy flows (value added service, realising 2259 FTR EVSE network portal).

The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
132	EVSE Operator	109	% failed requests	Percentage of failed requests to display EVSE connection point data	%	(Number of failed requests / total number requests) * 100	QoS

9.3.36 2265 UC EVSE network portal financial information

A section of a web portal enables EVSE network operator to visualize EVSE connection points and obtain financial information about the EVSE viewed at multiple levels (value added service, realising 2259 FTR EVSE network portal).

The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
132	EVSE Operator	110	% failed requests	Percentage of failed requests to display EVSE financial data	%	(Number of failed requests / total number requests received) * 100	QoS

9.3.37 2266 UC EVSE network maintenance portal

A section of web portal to enables EVSE network operator to visualize EVSE connection points with maintenance information about the EVSE viewed at multiple levels with the possibility to set up selected maintenance orders (value added service, realising 2259 FTR EVSE network portal).

The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
132	EVSE Operator	111	% failed requests	Percentage of failed requests to display EVSE maintenance data	%	(Number of failed requests / total no or requests) * 100	QoS

9.3.38 2267 UC Driver portal account management

A web or mobile application enables EV Driver view details of his account and manage his account and assigned RFID cards (value added service, realising 2258 FTR Driver portal).

The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
133	Vehicle Driver	112	% failed requests	Percentage of failed requests to access and manage EV account data	%	(Number of failed requests / total number requests) * 100	QoS

9.3.39 2268 UC Driver portal search, reserve and control charging

Part of web or mobile application to visualize EVSE connection points based on search criteria and enable EV driver to reserve a charge pole and select a charge profile, if applicable (value added service, realising 2258 FTR Driver portal). The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
133	Vehicle Driver	113	% failed requests	Percentage of search results which cannot be fulfilled	%	(Number of failed requests / total no of requests) * 100	QoS
132	EVSE Operator	113	% failed requests	Percentage of search results which cannot be fulfilled	%	(Number of failed requests / total no of requests) * 100	QoS
133	Vehicle Driver	114	search time	Time taken to return requested search results	ms/request	Average response time per user request	Time
132	EVSE Operator	114	search time	Time taken to return requested search results	ms/request	Average response time per user request	Time

9.3.40 2270 UC Application for authorization and payments

Part of Driver portal mobile application that allows the EV driver to communicate with EVSE, e.g. identify through different means (NFC, QR), apply a coupon before or at the end of charging, pay for charging, and other (value added service, realising 2258 FTR Driver portal). The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
133	Vehicle Driver	115	% failed requests	Percentage of failed attempts to pay for charging through the driver portal	%	(Number of failed attempts / total number attempts) * 100	QoS

9.3.41 2287 UC Integration of car sharing

The EV Car Sharing promotes the diffusion and the optimization of the usage of electric vehicles in city contexts where often traffic and congestion problems occur. To speed up the process and to improve the offer and the quality of the service, two aspects are hereby considered:

- The integration of EVSE operator back-end and Car Sharing Management System: some information that are present in the EVSE operator backend as Recharge Cable Status, or State of Recharge, are fundamental also in the CSMS, to optimize the booking algorithm and maximizing the frequency of access to the service.
- Managing a unique RFID Card to access the EV and to the EVSE to start/end recharge operations should improve and simplify the usability of the service.

Scope & Level	Value Added Service(s). Integration between the EVSE operator backend (e.g. Enel EMM system) and the Car Sharing Management System which could be a natural monopoly in each city. This service infrastructure allows the EV Car Sharing Users to access to the EV managed by EV Car Sharing company and the EVSE managed by EVSE Operator, through a dedicated online booking and by using only one RFID card.

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
143	EV	116	% failed requests	Percentage of failed attempts of EV car sharing user to make a reservation to use an EV	%	(Number of failed requests / total number of requests) * 100	QoS
131	EVSE	116	% failed requests	Percentage of failed attempts of EV car sharing user to make a reservation to use an EV	%	(Number of failed requests / total number of requests) * 100	QoS
133	Vehicle Driver	116	% failed requests	Percentage of failed attempts of EV car sharing user to make a reservation to use an EV	%	(Number of failed requests / total number of requests) * 100	QoS

9.3.42 2288 UC Direct Payment w and w/o service contract on multi-vendor charging infrastructure

The goal of this VAS infrastructure is to enable random EV customer to access charging service and perform direct payment without necessarily having a service contract in place. In case of using a smartphone application which retrieves the EVSE information through NFC, the NFC permits a fast and easy mobile payment for the recharge. In order to enable such scenario, the relevant information chain must be established between EV user, EVSE and EVSE Operator back-end, allowing for EVSP and Telecom Operator to step into the scenario according to the specific payment technology. In the more general scenario, the EV random user might choose at the EVSE a specific EVSP to by charging service from. In order to accomplish this goal, the EVSE ID needs to be retrieved at first from the EVSE. Such information could be harvested by multiple means, e.g. a smartphone application with a bidirectional NFC communication able to retrieve EVSE ID from the EVSE, a manual read of EVSE ID to be inserted in smartphone application front-end, a QR reading of EVSE ID. Once the EVSE ID information (including the EVSE Operator) is known to the smartphone application, the EV user might choose an EVSP and select it according to pricing conditions (when there is not a general B2C service contract in place) or can simply start the charging service when the smartphone application itself is already branded by a specific EVSP.

Finally, charging service authentication request is sent by the smartphone application to the EVSP or EVSE Operator according to the technical implementation of the VAS infrastructure. The payment method could easily be web based as no established SIM based infrastructure is in place at the time of writing these business requirements.

This VAS infrastructure needs an end-user capable smartphone application and, according to different payment and communication options, specific technical requirements on EVSEs.

Scope & Level	Value Added Service infrastructure. It allows EVs users to pay the charging service through a direct payment method, e.g. a smartphone application, with or without a B2C service contract with an EVSP. Enabling technology for direct payment could be Near Field Communication (web and SIM based) and QR code reading application. A whole set of B2B and B2C services would be realized within this VAS infrastructure

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
133	Vehicle Driver	117	% failed requests	Percentage of unsuccessful attempts to connect to the EVSE via the phone to pay for the charging service	%	(Number of failed requests / total number of requests) * 100	QoS
131	EVSE	117	% failed requests	Percentage of unsuccessful attempts to connect to the EVSE via the phone to pay for the charging service	%	(Number of failed requests / total number of requests) * 100	QoS

9.3.43 2289 UC Signalling ICEV inappropriately parking

The detection of the EV dedicated parking lot is crucial in the big city, since EV parking lots are often taken by non-Electric Vehicles. This way, an EVSE is able to discriminate the presence/absence of a car and in case of presence, if a charging session is not started in X minutes, it is able to understand the type of the vehicle (EV/ICEV). After detecting a Non-EV, the EVSE can inform the EVSE Operator Back End and a request for towing the car can be sent to the responsible institution (e.g. local police).

Scope & Level	Value Added Service infrastructure. Detection of a non-electric vehicle, such as ICEV, in an EV public reserved/dedicated parking lot and monitoring its status through EVSE using a parking sensing system.

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
133	Vehicle Driver	118	% time parking space is occupied by a non-EV	% of time managed parking site is occupied by a non-EV	%	(Amount of time occupied and “park only” mode is not selected/total time occupied) * 100	QoS
131	EVSE	118	% time parking space is occupied by a non-EV	% of time managed parking site is occupied by a non-EV	%	(Amount of time occupied and “park only” mode is not selected/total time occupied) * 100	QoS
143	EV	118	% time parking space is occupied by a non-EV	% of time managed parking site is occupied by a non-EV	%	(Amount of time occupied and “park only” mode is not selected/total time occupied) * 100	QoS

9.3.44 2290 UC Internet access at EVSE

The EVSE infrastructure deployment may serve as a broadband hot-spot wireless network for Internet access through EVSEs installed in semi-public places (airports, megastores, maxi cinemas).

Scope & Level	Value Added Service. The EVSE allows free internet access to both EV users and non EV users. The EV user may be authorized to freely access the Internet together with the charging authorization. The non EV user may access the Internet through a pay-per-use contract/prepaid. The internet access is performed through mobile devices only.

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
133	Vehicle Driver	119	% failed requests	Percentage of unsuccessful attempts to connect to the internet	%	(Number of failed requests / total number of requests) * 100	QoS
131	EVSE	119	% failed requests	Percentage of unsuccessful attempts to connect to the internet	%	(Number of failed requests / total number of requests) * 100	QoS

9.3.45 2323 UC Probe data collection

To goal is to collect and store data about journeys via GPS data (value added service). Information includes point of departure, route, range, travel time and destination.

The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
1579	Third Party Service Provider	120	% journey data unsuccessfully stored	Percentage of data about journeys via GPS not recorded	%	(Number of journeys in which data is not logged / The total number of journeys) * 100	QoS

9.3.46 2324 UC Journey analysis

The goal is to analyse trips of users and checks the range possibilities for the EV (value added service).

The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
1579	Third Party Service Provider	121	% of journeys which cannot be analysed	Percentage of journeys which cannot be analysed to determine if an EV can be used to make the journey	%	(Number of journeys in which cannot be analysed / The total number of journeys) * 100	QoS

9.3.47 2325 UC Assessment of usage pattern

The goal is to use collected and analysed journey data to draw comparison between usage of ICEV versus EV usage (value added service). The results compare cost of transportation, CO_2 emission and travel time.

The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
1579	Third Party Service Provider	122	% of journey comparisons between vehicles that are possible	Percentage of journeys which can be compared with respect to an EV and an ICEV	%	(Number of journeys which can be compared / The total number of journeys)*100	QoS

9.3.48 2331 UC Perform Telematics-based Smart Charging

The goal is to perform Telematics-based smart charging of the EV, via OEM V2B link to the EV (value added service).

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
128	EVSP	123	% of successful telematics based smart charging	Percentage of charging that can be successfully optimised via telematics assuming the required information has been provided	%	(Percentage of charging events that can be optimised via telematics / total number of charging events) * 100	QoS
143	EV	123	% of successful telematics based smart charging	Percentage of charging that can be successfully optimised via telematics assuming the required information has been provided	%	(Percentage of charging events that can be optimised via telematics / total number of charging events) * 100	QoS
134	OEM	123	% of successful telematics based smart charging	Percentage of charging that can be successfully optimised via telematics assuming the required information has been provided	%	(Percentage of charging events that can be optimised via telematics / total number of charging events) * 100	QoS
133	Vehicle Driver	123	% of successful telematics based smart charging	Percentage of charging that can be successfully optimised via telematics assuming the required information has been provided	%	(Percentage of charging events that can be optimised via telematics / total number of charging events) * 100	QoS

9.4 Roaming functional domain use case model

The Green eMotion Marketplace facilitates also information exchange that enables geographic roaming between countries and roaming either between EVSPs and EVSPs or EVSPs and EVSE Operators. Roaming is based on contractual clearing services performed by the CH, which is a third party application accessible through the Green eMotion Marketplace. Contractual clearing enables intra-country and inter-county roaming through the validation of contracts between different EVSE Operators and EVSPs as well as their respective customers. This functionality is of key importance to the Green eMotion project because it enables charging at different EVSEs with the use of a single contract provided by one EVSP. During its first release the CH application will only provide roaming and authorization services. Future releases of the CH may also provide Financial Clearing, which would improve financial and billing operations for e-mobility.

9.4.1 1510 UC Before charging

An EV driver can select a satisfactory EVSE location and find his way to it. EV driver may use services such as route planning, identification of available EVSE, charging location reservation, etc., and access these services through a compatible on-board interface (telematics, mobile app, phone call to a customer service centre or similar) with a service provider.

Scope & Level	Basic end-user services. This UC covers the phase from identifying the need for charged EV batteries, through making the charging decision, planning the route to the arrival at the selected or reserved charging location. The UC describes interaction between an EV driver and a device that is connected to a service provider. The EVSP might provide its services to the EV driver based on the interaction with other service providers directly or via the Marketplace.

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
1406	EVSE Operator Backend	61	% failed requests	Percentage of search results which cannot be fulfilled	%	(Number of failed requests / total number requests received) * 100	QoS
133	Vehicle Driver						

9.4.2 1512 UC Start a roaming charging process with CH

The goal is to start a roaming charge after the transaction has been validated by the CH (clearing service).

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
140	CH	162	Number of roaming sessions	Number of roaming sessions accounted in the CH	(integer)	Number of roaming sessions / month	Performance
128	EVSP	7	Total cost of roaming services	Roaming costs per charge event	€/charge event	Total cost of roaming services / total number of charge events	Cost

133	Vehicle Driver	8	% not sent roaming authorization messages	Number of authorization messages not sent due to connectivity issues, backend issues, or EVSP backend / EVSE operator backend has sent wrong data	%	(Number of authorization messages nor sent / total number of roaming authorization requests) * 100	QoS
		2	Identification and authorization time	Average time it takes to identify and authenticate a user	s/charge event	Total time for identification and authorization processes / total number of charge events	Time

9.4.3 1511 UC End a roaming charging process with CH

EVSPs receive correct CDRs in order to enable billing, reporting and statistics (clearing service). This UC is an internal CH procedure serving 2 business stakeholders: EVSP/EVSE operator. The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
1406	EVSE	10	% CDR contains wrong but consistent data	Wrong data is transmitted. Billing calculations are faulty because EVSP backend or EVSE operator backend have sent wrong data	%	(Number roaming process where CDR contains wrong but consistent data / total number of roaming processes) * 100	QoS
		9	% CDR is not transmitted	CDR is not received and billing cannot be calculated correctly due to connectivity issues or backend issues	%	(Number of roaming process where CDR is not transmitted / total number of roaming processes) * 100	QoS

9.4.4 1514 UC Create Customer Contract by Service Provider in CH

A Service Provider wants to initially create a contract for one of his customers and populate that information to the CH in order to enable faster roaming decisions (clearing service). This UC triggers the enablement of the roaming agreement with the end user for the CH functionality. The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
128	EVSP	14	% of not created consumer contracts	Number of consumer contract in the CH and all clearing requests have to go full round trip due to inconsistent data scheme or backend errors	%	(Total number of failed consumer contracts / total number of EVSP or EVSE contract requests) * 100	QoS

		13	Cost of consumer contract within CH	Average cost of create a consumer contract within the CH in order to enable faster roaming decisions	€/contract	Total cost of setting up consumer contracts / total number of consumer contracts	Cost

9.4.5 1516 UC Delete Customer Contract by Service Provider from CH

A Service Provider wants to delete a contract of one of his customers from the CH (clearing service). This UC allows the Service provider to delete a customer contract from the CH. This is an internal CH characteristic and has no functional effect on the end user.

The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
128	EVSP	17	% Consumer contract delete requests failed	Clearing requests are still granted due to faulty API call backend errors connectivity issues	%	(Total number of failed consumer contract delete requests / total number of consumer contract delete requests) * 100	QoS

9.4.6 1515 UC Change Customer Contract by Service Provider in CH

A Service Provider changes customer contract details which are stored in the CH (clearing service). This UC allows the service provider to make changes to the customer contract in the CH. The UC represents no functional changes to the end user.

The following PI has been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
128	EVSP	18	% EVSP consumer contract change requests failed	Contract cannot be changed due to inconsistent data scheme or backend errors	%	(Total number of failed EVSP consumer contract change requests / total number of EVSP consumer contract change requests) * 100	QoS

9.5 Energy functional domain use case model

The energy functional domain consists of one main business scenario, which is based on the idea of a centralized grid congestion management leveraging the smart metering backbone (for conventional energy market) and smart recharging infrastructure (for brand new electric mobility market) as deployed for example by Enel in Italy. This scenario is based on the basics of remote grid management, with the possibilities to enhance functionalities through the electric mobility infrastructures and exploit new services and opportunities in the smart-grid market, of which electric mobility is the very first operative example.

9.5.1 1604 UC Vehicle to grid signal

An EVSP, acting as aggregator in the energy market, offers energy to DSO (value added service). This energy is retrieved from the batteries of the EVs that are connected to the recharging infrastructure in a certain timeslot. The EVSP could also be not directly acting as aggregator but in connection with it, together with other EVSPs. In order to deploy this UC, the V2G supply signalling should be accomplished following this UC. This UC enables the DSO or other energy stakeholders to distribute the need for congestion management to multiple service providers through the marketplace. The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
128	EVSP	20	Cost of communications for V2G services	Unit cost of communications for EVSP V2G service provision	€/V2G provider	Total cost of communications / total number of enabled vehicles for providing V2G services	Cost
129	DSO	21	Response time for V2G services	Average time it takes to fulfil a V2G service request	s/V2G event	Total time for identification and authorization processes / total number of congestion events	Time
		22	% not granted V2G service requests	Number of not granted V2G services as % of all V2G services requested	%	(Number of not granted V2G service / total V2G service requests) * 100	QoS

9.5.2 1602 UC flexible load for congestion management

This UC enables the use of batteries flexibility for congestion management by DSO (value added service). Congestion may happen within a load area under critical timeslots and massive EV penetration may jeopardize energy disposal for electricity retailers' generic customers. Congestion management is within the duties of the DSO that manages the LV and MV grid. The DSO therefore is in charge of avoiding this hazardous condition and eventually reacts whenever network congestion within a load area is either forecasted or real-time detected, according to the technology used to monitor the energy distribution grid. EVSEs offer a service to support the DSO which can operate selectively.

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
132	EVSE Operator	23	Cost of communications for congestion management	Marginal cost of communications for EVSE congestion service provision	€/congestion service provider	Total cost of communications / total number of enabled EVs for providing congestion services	Cost
129	DSO	24	Response time for congestion service provision	Average time it takes to fulfil a congestion services request	s/load reduction request	Total time for identification and authorization processes / total number of V2G	Time

		25	% not granted congestion service requests	Number of not fulfilled load reduction requests as % of all congestion services requested	%	(Number of not fulfilled congestion services / total congestion service requests) * 100	QoS

9.5.3 1605 UC Reserve and activate ancillary services

An EVSP may offer, through a V2G capability to be established in the contracts with its partners, the possibility of helping the DSO in network safety and quality of service issues by offering a set of ancillary service, amongst which phase balancing and reactive power are the most significant ones.

Scope & Level	Value Added service. An EVSP offers aggregated flexible load as ancillary service to the DSO in order to help the DSO to fulfil the distribution rules established by the regulation framework in which it operates. In example, frequency and voltage will be adjusted in the local grid by drawing power from the batteries or interrupting load. This service will increase the quality of power in the grid and the DSO will reward the EVSP (aggregator) for provision of this service. Also, reducing the imbalance on phases on the LV substation is another example of UC of an ancillary service. Load switching from different phases will provide phase balancing to the grid that will reduce the losses on the distribution wires. Phase balancing will reduce losses in the distribution grid. DSO will reward the EVSP based on the savings it can reach by the reduction of losses. The injection of reactive power coming from a distributed generation unit (such as an EVSE) into the grid makes possible to reduce the amount of reactive power on the transmission lines, re-phasing the MV grid, and this is another example of ancillary service which may be enrolled here. All 973, 974 and 975 features can be deployed through this single UC. Other examples of ancillary services are: • scheduling and dispatch • reactive power and voltage control • loss compensation • load following • system protection • energy imbalance

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
132	EVSE Operator	26	Cost of communications for ancillary services provision	Marginal cost of communications for ancillary service provision	€/ancillary service provider	Total cost of communications/ total number of enabled vehicles for providing ancillary services	Cost
129	DSO	27	Response time for ancillary service provision	Average time it takes to fulfil an ancillary service request	s/ancillary service request	Total time for identification and authorization processes/ total number of V2G	Time

		28	% not granted ancillary service requests	Number of not fulfilled ancillary services requests % of all ancillary services requested	%	(Number of not fulfilled ancillary services /total ancillary services requests) *100	QoS

9.5.4 1601 UC provide balancing capacity

An EVSP, acting as aggregator in the energy market, will be able to offer energy from the batteries of the EVs used by its customers that are connected to the recharging infrastructure in a certain timeslot (value added service). This service may be published from an EVSP on the marketplace and provided to DSO / TSO or energy vendors, according to the regulatory framework. That is, In case of balancing services, the energy will be bought by the system operator. But if the EVSP is acting as an aggregator will participate in the different energy markets as any generator unit: for selling energy, and for offering ancillary services. Therefore, the unbundling precondition is true only in the energy market, but not in the ancillary services market.

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
128	EVSP	29	Cost of communications for balancing services	Unit cost of communications for balancing service provision	€/balancing provider	Total cost of communications / total number of enabled vehicles for providing balancing services	Cost
129	DSO	30	Response time for balancing services	Average time it takes to fulfil a balancing service request	s/balancing event	Total time for identification and authorization processes / total number of congestion events	Time
		31	% not granted balancing service requests	Number of not granted balancing services as % of all balancing services requested	%	(Number of not granted balancing service / total balancing service requests) *100	QoS

9.5.5 1597 UC Peak shaving

This UC enables peak shaving by aggregated EVs (V2G deployed for grid congestion management). The goal of peak shaving using V2G capability is to guarantee the energy provisioning to all the loads connected to the grid without deploying cut-off load management strategies under a congestion situation, thus letting the DSO to re-route the surplus of power gathered from EVSPs.

Scope & Level	Value added service. If network congestion management and V2G energy supply signal hypothesis are satisfied, an advanced solution for dealing with congestion issues would be using the V2G availability published from the EVSPs in order to simultaneously impact positively with a dynamic energy disposal on the grid by sharpening the load peaks in an adaptive way.

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
129	DSO	32	Response time for peak shaving services	Average time it takes to fulfil a peak shaving service request	Sec/peak shaving event	Total time for identification and authorization processes / total number of congestion events	Time
		33	% not granted peak shaving service requests	Number of not granted peak shaving services as % of all peak shaving services requested	%	(Number of not granted peak shaving service / total peak shaving service requests) *100	QoS

9.5.6 1572 UC Reduce Charge Power by DSO

DSO and EVSE are in a contractual relationship, which allows the DSO to send congestion signals to a particular EVSE operator in order to:

- interrupt charging.
- reduce the throughput of the CP.

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
132	EVSE Operator	34	Cost of communications for charging reduction services	Unit cost of communications for charging reduction service provision	€/charging reduction provider	Total cost of communications / total number of enabled vehicles for providing charging reduction services	Cost
129	DSO	35	Response time for charging reduction services	Average time it takes to fulfil a charging reduction service request	Sec/charging reduction event	Total time for identification and authorization processes / total number of congestion events	Time
		36	% not granted charging reduction service requests	Number of not granted charging reduction services as % of all charging reduction services requested	%	(Number of not granted charging reduction service / total charging reduction service requests) * 100	QoS
		162	Number of roaming sessions	Number of roaming sessions accounted in the CH	(integer)	Number of roaming sessions / month	Performance

9.5.7 1596 UC Peak load threshold on a substation

DSO defines thresholds peaks on each substation. It is within the DSO responsibility to foresee or evaluate from historical analysis energy statistics the expected peak per hour and/or day/month, in order to minimize shortages of energy supply and to fulfil the QoS rules set by the regulatory framework.

Scope & Level	Value added service. Within the MV/LV energy distribution management domain, the peak energy disposal per load area is one of the fundamental design parameters for the substations and grid reinforcements/maintenance.

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
129	DSO	43	% not granted History of EVSE use service requests	Number of not granted History of EVSE use services as % of all history of EVSE use services requested	%	(Number of not granted history of EVSE use service / total history of EVSE use service requests) * 100	QoS
		38	% not granted peak load threshold service requests	Number of not granted peak load threshold services as % of all peak load threshold services requested	%	(Number of not granted peak load threshold service / total peak load threshold service requests) * 100	QoS
132	EVSE Operator	42	Cost of communications for history of EVSE use services	Unit cost of communications for History of EVSE use service provision	€/History of EVSE use provider	Total cost of communications / total number of enabled EV for providing history of EVSE use services	Cost
		37	Cost of communications for peak load threshold services	Unit cost of communications for peak load threshold service provision	€/peak load threshold provider	Total cost of communications / total number of enabled EV for providing peak load threshold services	Cost

9.5.8 1598 UC Aggregated EV charge overview by the DSO

This UC creates and distributes through the marketplace the aggregated current charging information of EVs in the area of a DSO. The service could be used by a Service Requestor such as the TSO or an Energy Vendor (according to the regulatory framework) to monitor the power eventually available, after the network safety and quality preconditioning made by the DSO. This service could also be used for marketing purposes by OEMs in order to influence charging behaviour of the average customer (e.g. people may unplug their vehicle once it reaches 50% recharge).

Scope & Level	Value added service. The overview of current EV charge is meaningful information that an EVSP, acting as Service Provider in the marketplace, can use in order to deliver benefits to its customers and sell or support services for others business actors in the electric mobility market.

The following PIs have been defined.

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
129	DSO	41	% not granted charging overview service requests	Number of not granted charging overview services as % of all charging overview services requested	%	(Number of not granted charging overview service / total charging overview service requests) * 100	QoS
		40	Response time for charging overview services	Average time it takes to fulfil a charging overview service request	s/charging overview event	Total time for identification and authorization processes / total number of congestion events	Time
128	EVSP	39	Cost of communications for charging overview services	Unit cost of communications for charging overview service provision	€/charging overview provider	Total cost of communications / total number of enabled vehicles for providing charging overview services	Cost
138	Service Requester	41	% not granted charging overview service requests	Number of not granted charging overview services as % of all charging overview services requested	%	(Number of not granted charging overview service / total charging overview service requests) * 100	QoS
		40	Response time for charging overview services	Average time it takes to fulfil a charging overview service request	s/charging overview event	Total time for identification and authorization processes / total number of congestion events	Time

9.6 Other PI without specific UCs

Actor Id	Actor name	PI Id	PI name	PI description	PI result format	PI Formula	PI Category
128	EVSP	126	EVSP fixed costs	EVSP staff cost and EBIT	€/year	Yearly EVSP staff cost and EBIT	Cost
136	Marketplace Operator	127	Marketplace fixed costs	Marketplace staff cost and EBIT	€/year	Yearly Marketplace staff cost and EBIT	Cost
140	CH	128	CH fixed costs	CH staff cost and EBIT	€/year	Yearly CH staff cost and EBIT	Cost
132	EVSE Operator	129	EVSE fixed costs	EVSE operator staff cost and EBIT	€/year	Yearly EVSE operator staff cost and EBIT	Cost
133	EVSE Operator	130	EVSE infrastructure cost	EVSE infrastructure cost including hardware and software assets	€/year	Yearly EVSE infrastructure amortization cost including hardware and software assets	Cost
136	Marketplace Operator	132	Marketplace access cost	Average marketplace access cost for service provision	€/access	Marketplace yearly costs / total number of service requests	Cost

9.7 Other UCs without PI definition

UC Id	UC Name
1521	Status for cars maintained by fleet manager
1239	Search and select services
1484	View Service Details
1487	Download Service Specification
1478	Download Service Content
1245	Search and select service contracts
1625	Create Request for new service
1623	View Details of Request of New Service
1620	Search and Select Requests for New Services
1626	Change Request for new service
1627	Delete request for new service
1471	View Service Transaction Details
1242	Search and Select Service Transactions
1482	View Service Contract Template
1624	Change Service Contract Offering
1479	View Service Contract Details
1470	Create Service Contract Offering
1480	Create Service Contract Termination Request
1481	Confirm Service contract Termination
1247	Confirm Service Contract Change
1246	Create Service Contract Change Request
1490	Suspend/Resume Service Contract by Service Requester
1477	Create Service Registration Contract
1494	Publish Service
1489	Upload Service Specification
1488	Upload Service Content
1476	View Standard Interface Details
1475	Search and Select Standard Interface
1486	Enable/Disable Service Permanently
1257	Propose New Standard Interface
1373	Search and Select Business Partner
1376	Change Business Partner Account
1377	View Business Partner Account Details
1378	Change Business Partner Account Details
1599	UC History of EVSE use
1250	UC Register Service
2260	Driver portal homepage & general information
2332	Register for Telematics-based Smart Charging